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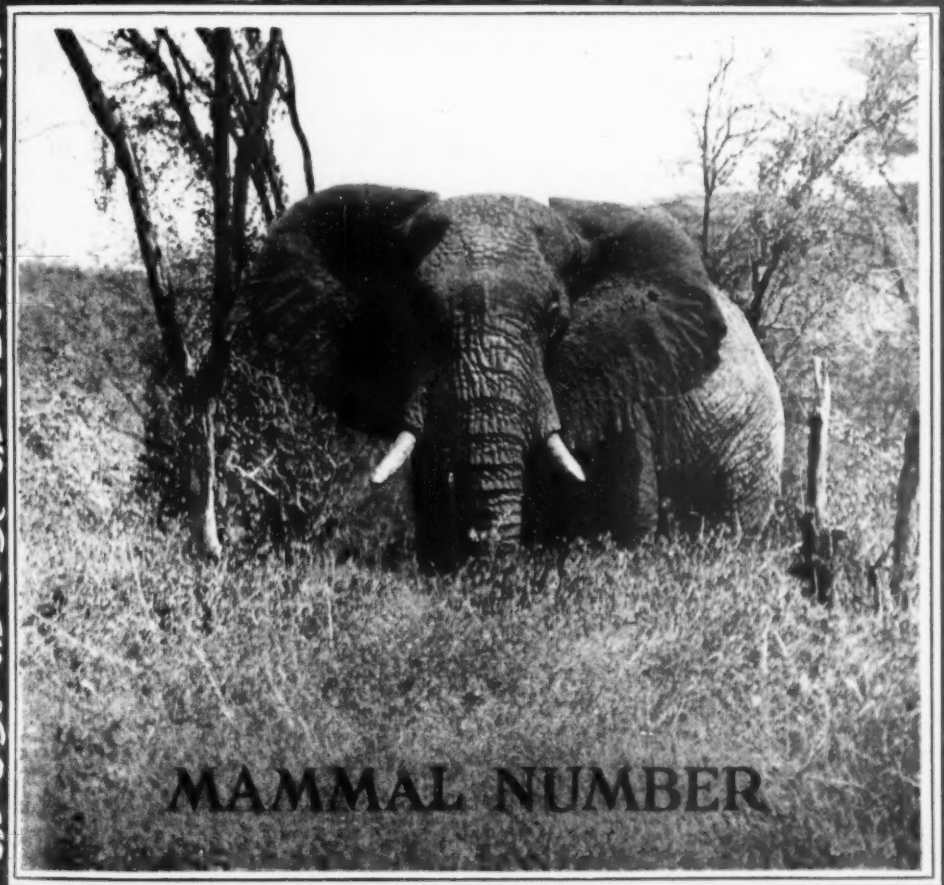
NATURAL HISTORY



MAMMAL NUMBER

JOURNAL OF THE AMERICAN MUSEUM OF NATURAL HISTORY

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NATURAL HISTORY

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DEVOTED TO NATURAL HISTORY, EXPLORATION, AND THE DEVELOPMENT OF PUBLIC EDUCATION THROUGH THE MUSEUM

MAMMAL NUMBER

H. E. ANTHONY, EDITOR

NOVEMBER—DECEMBER

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From a mural in the American Museum of Natural History painted by Chas. R. Knight under the direction of Henry Fairfield Osborn

RESTORATION OF THE GREAT POOL AT RANCHO LA BREA

The painting shows the ground-sloth, *Mylodon*, the saber-tooth tiger, *Smilodon*, and the great condor-like vulture, *Teratornis*, in the foreground, while the huge imperial elephant may be seen against the distant hills

NATURAL HISTORY
VOLUME XXV NOVEMBER–DECEMBER NUMBER 6

Mammals and Birds of the California Tar Pools

BY HENRY FAIRFIELD OSBORN
Honorary Curator of Vertebrate Palæontology, American Museum

THE story of the California tar pools of Los Angeles and McKittrick is a romance of Nature and Civilization, of the prehistory of California, and of its present economic resources. The now famous formation of the Rancho-la-Brea, referred to by early historians of southern California, was formerly the property of Major Henry Hancock, and for a period was worked extensively for asphaltum and fuel. The bones thus uncovered were recognized as prehistoric, but attracted little notice until 1906, when Dr. John C. Merriam realized their great importance and began excavation for the University of California. His scientific studies and those of his colleagues and students on the fossil birds and mammals extended into a vast literature. In 1913 the whole tract of thirty-two acres, including all the fossil-bearing asphalt pits at Rancho-la-Brea, was granted to Los Angeles County by George Allan Hancock as a memorial to his parents, Major Henry Hancock and Mrs. Ida Hancock. The present article brings back to life these birds and mammals as revealed by twenty years of excavation and research.

NATURE does nothing by halves in the great State of California, sculpturing the longest and greatest coast line, rearing the loftiest mountain peak in the Union, carving the grandest glacial gorges, preserving the tallest of the ancient conifers of the world, nourishing the most varied glacial flora of the parks of the High Sierras, of the humid coasts, of the arid and torrid deserts, and harboring a still active volcano—thus Nature builds the golden state out of her superlatives!

While quick to display her present natural grandeur, California has been slow to reveal her prehistoric glory. The 'Ancient Territory of Nebraska' (including the present states of Nebraska and the Dakotas) and the states of Wyoming and Montana, as well as of New Mexico and Arizona, have hitherto surpassed in prehistory our great Pacific Coast state. This is because California was still in the making of her mountains and her coast lines during the Age of Reptiles and the Age of Mammals. Her sparse records of the Age of Mammals have only in recent years been unearthed by John C. Merriam and his students. As if to compensate us for this long prehistoric silence in the Tertiary or Age of Mammals, California suddenly reveals with unprecedented fullness and completeness her life during the Quaternary or Age of Man. Her bird life is recorded with unparalleled fullness in the tar pools of Los Angeles and of McKittrick, and the rarest of all fossil life is bird life, owing to the fragile nature of the bird skeleton. In the same tar pools the mammal life of early Quaternary or Pleistocene time was suddenly revealed as nowhere else in the world with such redundant fullness and completeness.

The long-famous Pliocene deposits of the Pikermi of Greece and of the Island of Samos, even the wonderful Lower Miocene assemblage of the Agate Spring quarry of Nebraska, fade in comparison with the fossil hosts of the tar pools, which include numerous representatives of the *entire large bird and mammal fauna* of the southern California region at the time the pools were capturing their prey.

The following is a partial and in-

[1]The illustrations of the Rancho-la-Brea murals are from photographs copyrighted by the American Museum.

complete summary of the numbers of mammal remains in the Rancho-la-Brea pools excavated up to the year 1920:

Fig. 2.—The old Rancho-la-Brea (Ranch of the Tar Pools), property of Major Henry Hancock, surrounded by trees and clumps of cactus, the 'Brown pool' and pits (9, 10, 11, 12) in the foreground, oil-pumping wells above the oil-bearing strata in the middle distance, and the Coast Range beyond. In this large pool was secured, shortly after the discovery, the first Los Angeles High School collection, also skeletons of the sloth (*Mylodon*), and a complete mastodon skeleton.

This and succeeding photographs by courtesy of the Museum of History, Science and Art, Los Angeles

IMPERIAL MAMMOTHS (*Archidiskodon imperator*)—parts of 17 or more individuals.

SMALLER SHASTA SLOTHS (*Nothrotherium shastense*)—13 or more.

ANCIENT BISONS (*Bison antiquus*)—70 or more.

GIANT GROUND-SLOTHS (*Mylodon harlani*)—60 or more.

WESTERN FOSSIL CAMELS (*Camelops hesternus*)—60 or more.

ARCH-FRONTED HORSES (*Equus occidentalis*)—17 or more.

CALIFORNIA SABRE-TOOTH TIGERS (*Smilodon californicus*)—2000 or more.

DIRE OR "GRIM" WOLVES (*Ænocyon canis dirus*)—3000 or more.

The carnivores, such as the dogs and the sabre-tooths, predominate over the herbivores, such as the sloths, camels, horses, bisons, mastodons, and mammoths: similarly, in the air the carnivorous birds predominate over the aquatic and shore birds. Consequently, we are led to a death-cycle theory of the foot-entangling tar pools somewhat as follows: all the quadrupeds, through instinct or intelligence, avoided the dangerous tar pools, except perhaps in seasons of drought, when, driven by extreme thirst, they lost their caution and ventured on the treacherous tar surfaces, which the thin sheets of water barely covered.

A parallel today to this lack of caution is the reckless approach of African quadrupeds to water pools in periods of severe drought, or the eating by hungry quadrupeds of poisonous plants which are instinctively avoided in times of food-plenty. In a similar manner, driven by hunger, carnivorous wolves and sabre-tooths lost their instinctive cautiousness when attracted by the freshly entrapped carcasses of the larger or smaller quadrupeds. Just as today hyenas and vultures gather in numbers around the decaying carcass of an African

zebra after the lion, the king of beasts, has taken his fill, so it is not improbable that wolves and sabre-tooths came in numbers or packs, while the giant lions (*Felis atrox bebbi*) and the short-faced bears (*Arctotherium californicum*) came singly and were rarely attracted to the tar pools.

It is to all these different phases and episodes of the Lower Pleistocene life of southern California that the present article is devoted.

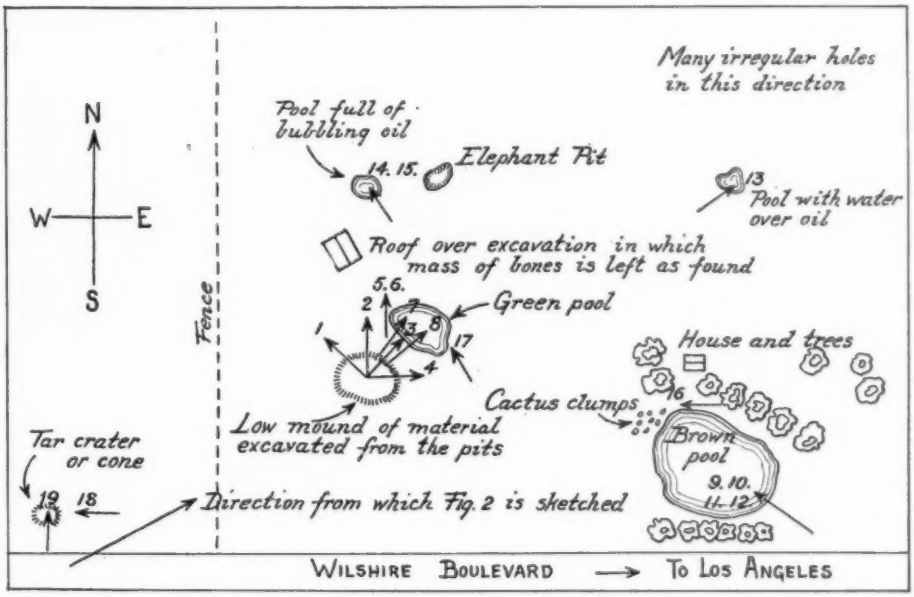


Fig. 3.—Key to the frontispiece and Fig. 8, showing the location of the Rancho-la-Brea (16), of the 'Brown pool' (9-12), of the 'Green pool' with pits (1-8, 17), and of the elephant pit (14, 15). The oblique arrow in lower left-hand corner indicates the direction from which the great mural reproduced in the frontispiece and in the corresponding Fig. 8 was drawn

LANDSCAPE STUDIES IN THE MAKING OF THE GREAT MURALS

For all these reasons the place of honor on the southeast walls of the Hall of the Age of Man is given to the mammalian life of southern California during the early periods of the Ice Age; the four mural panels, two of larger, two of smaller size, as reproduced in the accompanying illustrations, depict all the principal elements of the fauna. Whereas the entire Hall of the Age of Man epitomizes 125 years of most difficult and varied research, the murals and exhibits of its southeast walls display the knowledge we have gained in the relatively brief period of 19 years since Dr. John C. Merriam in 1906 recognized that the tar pools of the now world-famous Rancho-la-Brea were crowded with a vast number of the bones of a long extinct fauna. In describing this wonderful region let us reverse the order of thought usually employed by palæontologists and begin with the present condition of the tar pools—the machinery of the great wells supplying oil to the industries and navigation of the world—wend our way slowly back into the past, and thus convey to the reader some faint conception of the stupendous changes which have taken place and

of the long and tedious processes of exploration, research, and reasoning which have brought this marvelous ancient world right out of the grimy material surroundings of a modern oil field.

In the inspiring companionship of California's adopted son, John Muir, of Stephen Tyng Mather, leader in our national park and forest conservation movement, and of John C. Merriam, discoverer of the fauna of the tar pools, the present author has visited every part of the great State and with Joseph D. Grant and other California idealists is battling to save the redwoods from destruction. For the purposes of the mural restoration of the great landscape during the arid summer season, the author took three journeys to this region, guided by Doctor Merriam and the late Director Frank S. Daggett of the Los Angeles Museum, and accompanied once by the enthusiastic photographer, Russell T. Kirby, to whom the mountain profiles of the murals are due. Referring to our Figures 8 and 8a and to the diagram, Mr. Kirby wrote February 25, 1920:

> I got up my courage finally to go over to the Huntington Hotel and see Professor Osborn. His idea is to make a picture in the direction of the big arrow on the other side, showing a group of sloths struggling in a pit with the sabre-tooth tiger prowling around. Mountains in the background drawn so accurately as to be recognizable. He thinks the pit had rather gently sloping banks, that there were numerous trees about (the remains of a certain McNab's cypress have been found packed down among the bones), and that the animals came there to drink the water retained on the oily surface and took great risks to obtain it because of severe drought.

The controlling idea in the composition is to place the tar pools in the foreground surrounded by one or more groups of animals, with the Coast Range in the background. This part of the Coast Range is now famous, since from its center rises Mt. Wilson, on the summit of which is the observatory designed by George Ellery Hale and erected with the aid funds of the Carnegie Institution The great telescopes of this observatory are capable of locating and measuring by the Michelson method such gigantic stars as Betelgeuse.

During the early Ice Age, when the great animals frequented the drinking pools spread over the treacherous tar beneath, these mountains with the same very simple contours were present. The snow, however, descended much lower on their sides, and the artist must therefore present the Range with the higher summits covered with snow and snowcaps reaching much lower down the mountainsides than they do now even during the winter season. The precise location of the pits where the different kinds of animals were found was surveyed and plotted with very great accuracy under the direction of Doctor Merriam and Director Daggett. Every single bone of the thousands taken out was definitely located, so that the association of parts with individual skeletons, as in the case of the imperial mammoth and certain of the ground-sloths, is definitely recorded.

ANIMAL STUDIES FOR THE MURAL COMPOSITION

The animal studies for the mural composition were guided by the researches on the mammals of John C. Merriam, followed by those of William D. Matthew and Chester Stock, by the studies of Osborn on the proboscideans and by the researches on the birds of Loye Miller, aided by L. E. Wyman.

The recent summary of the mammal fauna by Chester Stock in his great memoir of 1925 includes twenty-nine species of larger mammals—carnivores, edentates, artiodactyls, perissodactyls and proboscideans—not including the insectivores, bats, and numerous and varied rodents.

The preponderance of extinct genera and species indicates that the tar pool traps were most effective during one or more centuries of *arid early*

MAMMALS

CARNIVORA

Arctotherium *lifornicum* Merriam, extinct California short-faced bear; also of South Americ[illegible] Andean region

Ursus sp., tr[illegible] bear; about size of the living grizzly (*Ursus horribilis*).

Canis (*Ænocyon*) *dirus* (Leidy), the great extinct dire wolf; also found fossil in Indiana.

Canis (*Ænocyon*) *milleri* (Merriam), a variety of the extinct dire wolf.

Canis occidentalis furlongi Merriam, related to the western wolf, *Canis occidentalis*.

Canis ochropus orcutti Merriam, close to the living coyote of California, *Canis ochropus*.

Canis andersoni Merriam, extinct short-headed coyote-like wolf.

Urocyon californicus Mearns, the living species of gray fox of southern California.

Taxidea, the badger; possibly a new species; also of western America.

Spilogale, a species of spotted skunk.

Mephitis occidentalis, the living western skunk; possibly a new species.

Mustela, a species of the living marten.

Smilodon californicus Bovard, extinct California sabre-tooth tiger.

Felis atrox bebbi Merriam, extinct giant lion or wild cat of La-Brea; also fossil in southern United States.

Felis daggetti Merriam, Daggett's puma or mountain lion, extinct

Lynx, near *rufus californicus* Mearns, Fisher's lynx or caracal.

Felis lynx, the lynx.

EDENTATA. Edentates, Ground-sloths. All extinct.

Mylodon harlani Owen, Harlan's giant ground-sloth; also of South America.

Mylodon harlani tenuiceps Stock, small-headed species of the above.

Megalonyx jeffersonii californicus Stock, large-clawed sloth of California; also fossil in eastern United States.

Nothrotherium shastense Sinclair, Shasta smaller ground-sloth; also of Brazil and the Argentine.

ARTIODACTYLA. Camels, antelope, deer, bison, peccaries.

Camelops hesternus (Leidy), fossil western camel; also of northern California.

Capromeryx minor Taylor, small fork-horned antelope; also of western Nebraska.

Odocoileus sp., species related to our Virginia deer; also of temperate North America.

Bison antiquus Leidy, Leidy's ancient bison, narrow-fronted; also of eastern United States.

Platygonus, extinct crest-toothed American peccary.

PERISSODACTYLA. Horses, tapirs.

Equus occidentalis Leidy, extinct arch-fronted horse of California; also of northern California.

Tapirus sp., a species of tapir; also of Central and South America.

PROBOSCIDEA. Elephants, mastodons.

Mastodon americanus, true American mastodon; also of central United States and Eurasia.

Archidiskodon imperator, imperial southern mammoth; also of central United States and Mexico.

RODENTIA. Hares, rabbits and many smaller rodents.

INSECTIVORA. Moles and shrews.

CHIROPTERA. Bats.

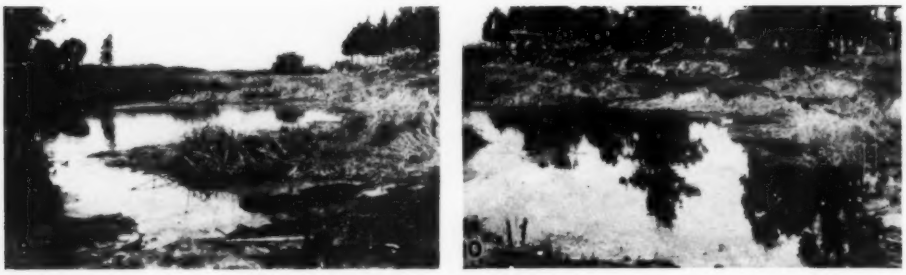


Fig. 4.—Two views of the 'Brown pool' adjoining the Rancho-la-Brea, showing the present appearance and location of pits 9 and 10, in which the early excavations of the Los Angeles High School yielded skeletons of the giant ground-sloth (*Mylodon harlani*) and American mastodon (*Mastodon americanus*)

Quaternary age; they then ceased to capture prey during a very long middle and upper Quaternary period of *moister* climate. In the mammal list there are many long-extinct genera: *Arctotherium*, *Ænocyon*, *Smilodon*, *Mylodon*, *Megalonyx*, *Nothrotherium*, *Camelops*, *Capromeryx*, *Platygonus*, *Mastodon*, and *Archidiskodon*. The greater number of species is extinct, namely, out of the total of twenty-nine species of mammals listed, twenty-one are extinct, only eight being so closely similar to living types as not to be separable specifically. These eight species are relatively small and inconspicuous mammals. All the larger kinds of predominant mammals which surrounded the tar pools are extinct. Another reason for recording these assemblages as of *early* Pleistocene age is the presence of the imperial southern mammoth (*Archidiskodon imperator*), an elephant belonging only to early Pleistocene time.

The same impression of great antiquity is given in the survey of bird life of the Rancho-la-Brea. Let us, however, first survey the mammal life more closely.

THE CARNIVOROUS MAMMALS

The *Canis* (*Ænocyon*) *dirus* was the dominant type of wolf in this region and in the central and eastern states; the type of this genus and species is from Evansville, Indiana. It includes the largest known individuals of the wolf group in America, the skull being especially large in proportion to the relatively light limbs, which show that it was a poor traveler. The great number of individuals in the Rancho-la-Brea pools suggests that this animal hunted in packs, attacking isolated quadrupeds and sloths. The hardly

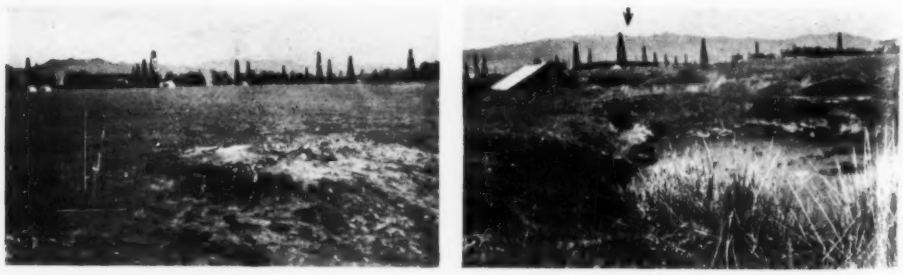


Fig. 5.—Right: the mound (2) in front of the 'Green pool'; in the distance the elephant (*Archidiskodon imperator*) pit (arrow). Left: fresh tar crater or cone (19) near the elevated point from which frontispiece was painted

Fig. 6.—Left: near the elephant (*Archidiskodon imperator*) pit below flow of bubbling oil (14). Center: McNab's Cypress (*Cupressus macnabiana*) excavated from the pit near by. Right: hardened surface of the 'Green pool' (17)

less numerous sabre-tooth (*Smilodon californicus*), of which more than two thousand individuals have been found, is about the size of the sabre-tooth of Florida (*Smilodon floridanus*); it is decidedly smaller and shorter-faced than the great extinct sabre-tooth (*Smilodon neogæus*) of the Pampean formation of Argentina and differs widely from the true lion and tiger in its short tail, its short, massive limbs, its abbreviated face. As pointed out by Matthew, the distinctive character of all the sabre-tooths is their ability to throw the jaw back upon the neck, as seen in the Frontispiece and Figure 8, thus completely exposing the dagger-like tusks.

The California short-faced bear (*Arctotherium californicum*) was an intelligent animal rarely captured in the tar pools; it is represented merely by a giant inferior canine tusk and giant foot-bones, which enable Merriam to compare this animal with the short-faced cave bear (*Arctotherium simum*) of northern California; it equalled or exceeded in size the gigantic living bears of Alaska. Relatively numerous is the giant cat of La-Brea (*Felis atrox bebbi*), of which fourteen skulls have been found. First discovered in Mississippi (*Felis atrox* Leidy), this is a true feline, with the majestic proportions of the lion, including long limbs, but far exceeding either the African or the Asiatic lion in size, the largest individuals nearly equalling the Kadiak bear (*Ursus merriami*); its nearer zoölogical affinities are rather with the American felines than with the true lions or tigers of the Old World. Among the other felines are Daggett's puma or mountain lion (*Felis daggetti*), a lynx near the existing California species, and representatives of the dog family besides the dire wolf (*Ænocyon dirus*)—a western fossil wolf

Fig. 7.—Jack rabbit (*Lepus californicus*) trapped on surface of the tar pool exactly as its ancestors were trapped in Lower Pleistocene times

Fig. 8.—The Tar Pool Death Cycle, First Phase. Location and restoration of the chief tar pools of the Rancho-la-Brea, according to the knowledge afforded by Figs. 2-7. Reproduced from the Rancho-la-Brea mural drawn by Charles R. Knight under the direction of Henry Fairfield Osborn.

This photograph and the Frontispiece do but scant justice in color to the original 9×25 foot mural on the southeast wall of the Hall of the Age of Man. The mural, completed in 1921, was three years in preparation. After repeated visits to the scene, the writer finally selected the exact point from which the painting should be composed.

The painting depicts the moment when one ground-sloth (*Mylodon*) has been entrapped and his two companions are standing guard to ward off the threatened attack of the sabre-tooth tiger (*Smilodon*).

The great condor (*Teratornis*) is drawn to scale from the description of Loye Miller; the sabre-tooth (left), chiefly from the anatomical studies of J. C. Merriam and W. D. Matthew; the great ground-sloth (right), chiefly from the studies of J. C. Merriam and Chester Stock; the imperial mammoth (center in the distance), from the studies of H. F. Osborn. The cypress trees were drawn from McNab's Cypress (*Cupressus macnabiana*) found in one of the pits. The mountain profile was drawn from studies and photographs secured by Russell T. Kirby

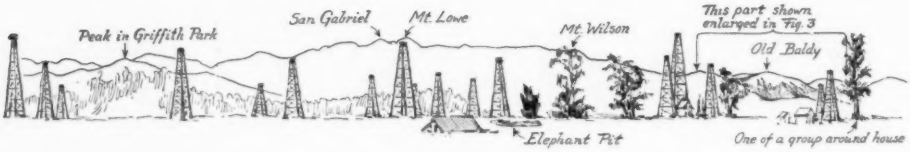


Fig. 8a.—Key to the Coast Range and chief mountain peaks shown in the above restoration. Mt. Wilson is famous all over the world as the site of the great Carnegie Observatory. 'Old Baldy' is represented as lightly covered with snow in Pleistocene times

(*Canis occidentalis furlongi*), and two species related one to the living coyotes and the other to the living gray fox.

THE EDENTATES AND SLOTHS, HORSES AND TAPIRS

Unlike the Carnivora, which are all of North American or north Asiatic parentage, the sloths are of South American origin, nearer or more remote, including the three principal types, Harlan's giant ground-sloth (*Mylodon harlani*), the giant large-clawed sloth (*Megalonyx jeffersonii californicus*), and the Shasta smaller ground-sloth (*Nothrotherium shastense*)—all slow-moving quadrupeds, defenseless in tooth structure but with large and formidable fighting claws on the fore-feet and more or less impenetrable coarse hair and hide reinforced with dermal ossicles. The wide distribution of these animals all over the southern and middle United States region tends to prove that the powerful adults could defy the larger carnivores, except when weakened by old age or when entrapped in the tar pools.

The mural (Frontispiece and Fig. 8) represents two of these sloths standing by a doomed comrade and defying an approaching sabre-tooth. According to Chester Stock in his monograph of 1925, "The Pleistocene Megalonychinæ and Mylodontidæ of Rancho-la-Brea," Harlan's *Mylodon* ranged

fearlessly through open or partly forested country and in South America inhabited the great stretches of the Pampas, always in the threatening companionship of sabre-tooth tigers and in the friendly company of various species of wild horses. The large-clawed *Megalonyx* enjoyed as wide a range in North America as *Mylodon* but

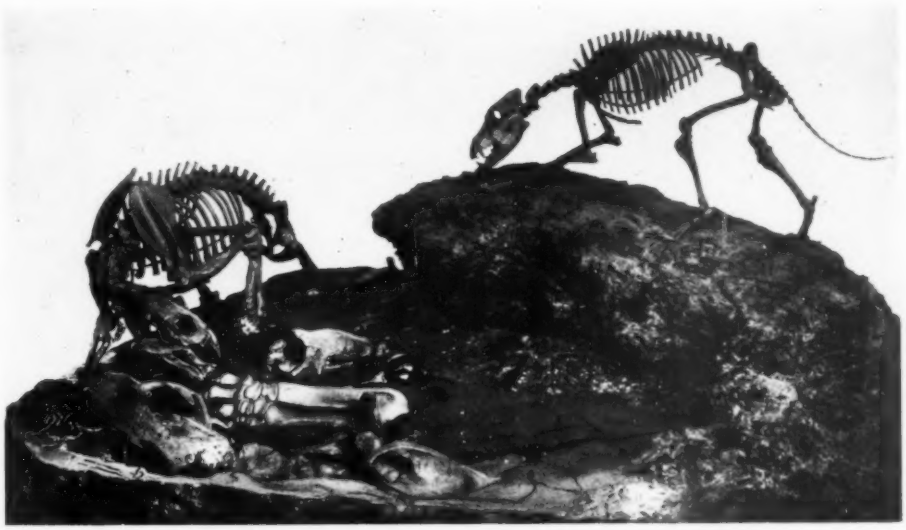


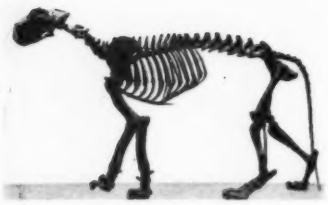
Fig. 9.—The Tar Pool Death Cycle, Final Phase. Reproduced from the American Museum Asphalt Group completed in 1913 under the direction of J. C. Merriam and W. D. Matthew. This group represents the final phase in the death cycle, following that of the mural shown in the frontispiece and Fig. 8. The unfortunate ground-sloth (*Mylodon*) has sunk deeply into the treacherous tar; the sabre-tooth (*Smilodon*) is also hopelessly entangled, but his growl wards off the dire wolf (*Æ nocyon canis*). In such death cycles as these were captured more than 60 ground sloths, 2000 sabre-tooths, and 3000 wolves

has not been certainly identified in South America. The smaller large-clawed sloth *Nothrotherium*, a long-limbed form, ranged from Brazil northward into Texas and California, occurring in cave deposits and first discovered in a cave near Mt. Shasta, to which it owes its specific name *shastense;* it is of true South American parentage of remote Miocene time.

Eleven excellent skulls of the western fossil horse (*Equus occidentalis* Leidy) prove that this intelligent animal was occasionally entrapped; this western arch-fronted species, first discovered in northern California, differs from the modern horse (*E. caballus*) in its shorter and wider nostril region, more convex forehead or arch-fronted face, more massive lower jaw, and in the simplicity of the enamel pattern of its grinding teeth; it was a California or Pacific Coast outlier of the great herds of horses, small and large, swift and slow-footed, which ranged all over the United States until the last period of glaciation. The tapir, a distinctive forest-living animal, is of very rare occurrence in the Rancho-la-Brea pools.

THE MASTODONS AND ELEPHANTS

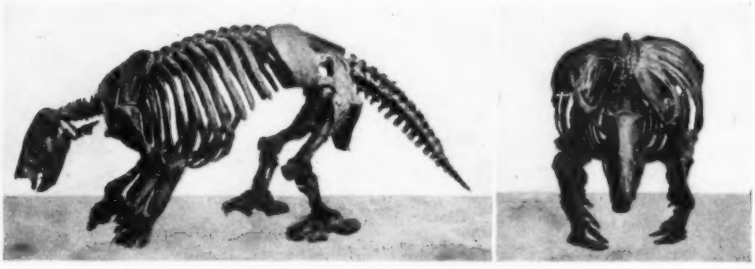
These highly intelligent proboscideans are rare in occurrence, although the true American mastodon (*Mastodon americanus*) was among the earliest discoveries in the large pool first explored. The finding of the mastodon is especially interesting, because this animal, which as early as



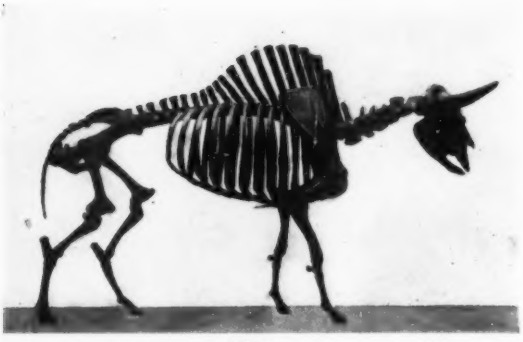
LION

SLOTH (FRONT AND SIDE VIEWS)

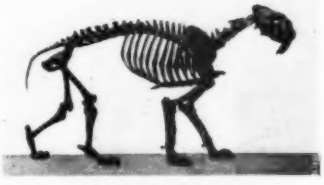
ANTELOPE



GIANT SLOTH (FRONT AND SIDE VIEWS)

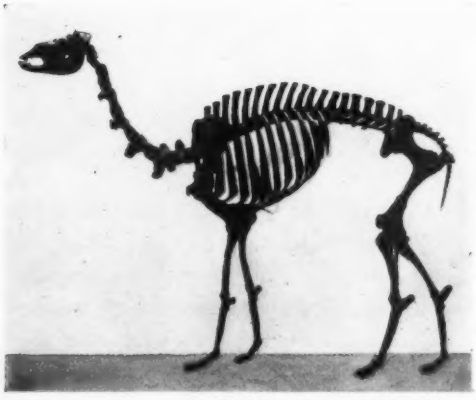


BISON

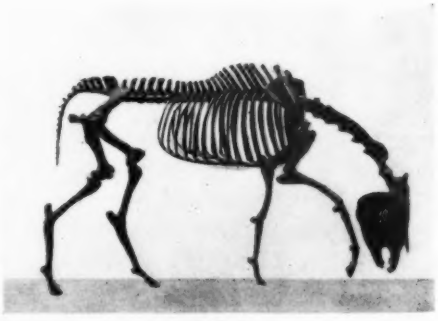


SABRE-TOOTH TIGER

WOLF



CAMEL



HORSE

Fig. 10.—Skeletons from the Rancho-la-Brea as mounted in the Museum of History, Science, and Art, Los Angeles, all reproduced in same scale. (1/50 natural size)

Miocene time entered North America from Asia and more remotely from northern Africa, throughout its entire range over the northern hemisphere is strictly a forest-frequenting proboscidean, as great a forest-lover as is the tapir. It is represented in the Los Angeles Museum by the skeleton of a small individual, certainly a female.

Most notable as regards its wide migration from southern Asia and most distinctive as indicating early Pleistocene age is the presence in this fauna of the imperial mammoth (*Archidiskodon imperator*), one completely assembled skeleton of which includes a perfect skull, unmistakably of the true sharply-crested shape distinctive

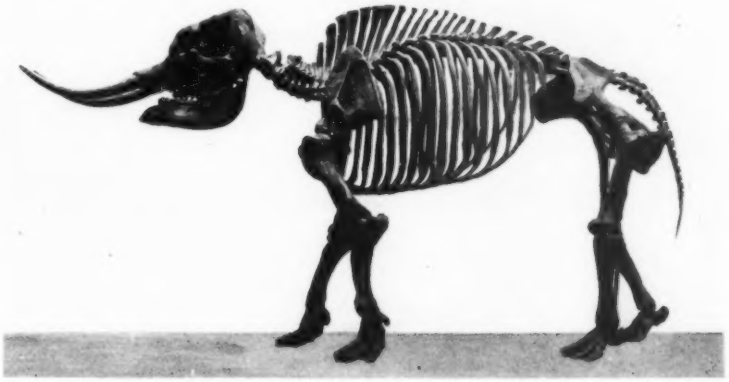
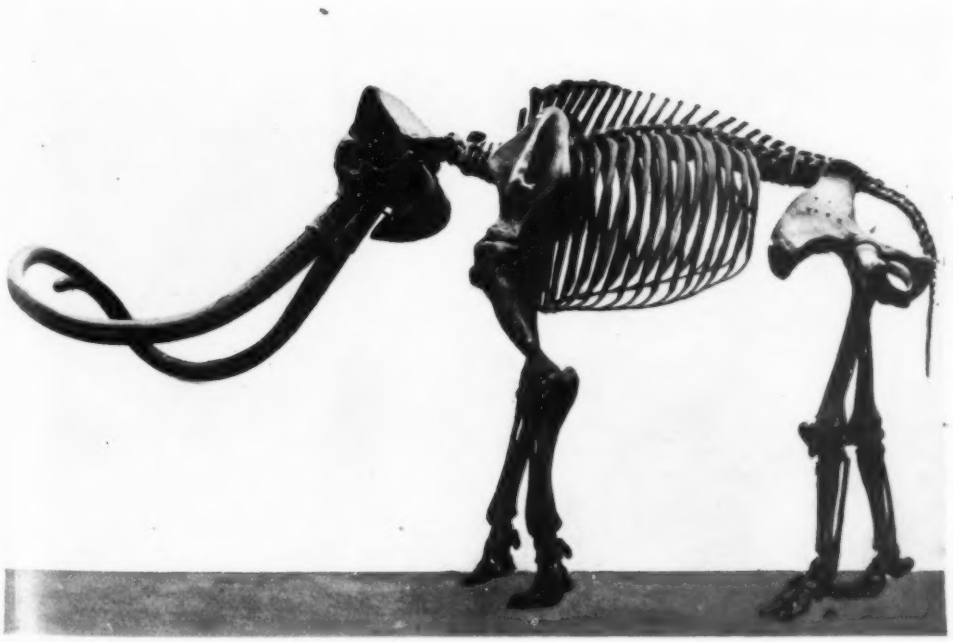


Fig. 10a.—Skeleton of American mastodon (right) and imperial mammoth (below) from the Rancho-la-Brea, as mounted in the Museum of History, Science, and Art, Los Angeles. (1/30 natural size)



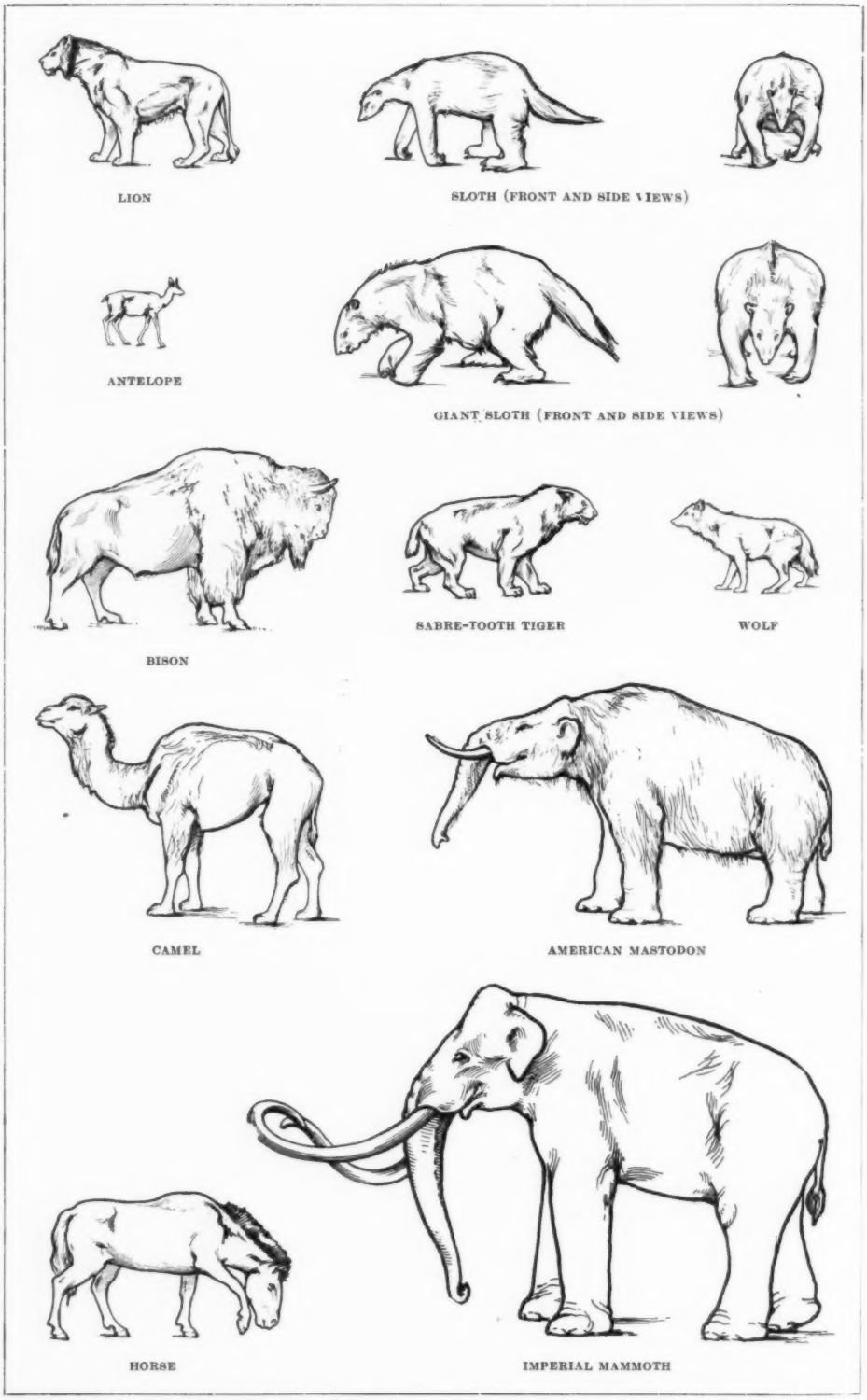


Fig. 11.—Outline restorations of the chief mammals of the Rancho-la-Brea, corresponding with the mounted skeletons pictured on pp. 536, 537. ($\frac{1}{75}$ natural size). Drawn by L. M. Sterling

Fig. 12.—Pack of Dire Wolves and Herd of Western Horses. Reproduced from the Rancho-la-Brea murals drawn by Charles R. Knight under the direction of Henry Fairfield Osborn. The scene represents a pack of seven dire wolves (*Ænocyon canis dirus*) in the foreground and middle distance, with the Coast Range and snow-capped 'Old Baldy' to the left seen through the branches of McNab's Cypress; to the right is part of a herd of fossil western horses (*Equus occidentalis*); in the foreground is the skull of a bison (*Bison antiquus*). The profile of the horse is incorrectly drawn; it should be more rounded or convex as in the existing Nordic horse (*Equus caballus nordicus*).] These intermediate scenes form a continuation of the great Rancho-la-Brea murals, which altogether fill a linear space of 50×9 feet, on the southeast wall of the Hall of the Age of Man of the American Museum. An adaptation of this series to the same scale is placed on the end wall of the Museum of History, Science, and Art of Los Angeles

of all the mammoths and totally different from the round-crested skull of the genus and species *Parelephas jeffersonii*, a genus and species characteristic of the more recent period of the Pleistocene. No trace of this more recent genus and species is found in the Rancho-la-Brea, another proof of the early Pleistocene age of this deposit.

The late Director Daggett observed the remarkable fact that practically all the elephant remains in the asphalt beds were taken from a single deposit, (14,15) known as 'the elephant pit'; here in a cone-shaped area fifteen by twenty-five feet in diameter at the surface, with an extreme depth of nearly thirty-five feet, were found limb bones of no less than seventeen elephants (*A. imperator*), together with a number of bones of the mastodon (*M. americanus*) and a great quantity of bones of the ancient bison (*B. antiquus*), of the giant ground-sloth (*Mylodon*), of the western camel (*Camelops hesternus*), of the western horse (*Equus occidentalis*), as well as of Carnivora—the giant lion, the sabre-tooth, the dire wolf, and the giant bear (*Arctotherium*). The elephants must have been trapped singly or in small groups, as the 'elephant pit' was too small to hold the huge bodies of seventeen elephants all at one time.

THE CAMELS, BISON, ANTELOPE, DEER, AND PECCARIES

Remains of the western camel (*Camelops hesternus*), estimated at sixty to seventy, are about as numerous as

Fig. 13. La-Brea Lion and Herd of the Camel-Llama. Reproduced from the Rancho-la-Brea murals drawn by Charles R. Knight under the direction of Henry Fairfield Osborn. This scene depicts the giant cat (*Felis atrox bebbi*) stalking a herd of camels (*Camelops hesternus*) unsuspiciously approaching a water pool. In the distance is a herd of fossil western horses (*Equus occidentalis*).

These camels are restored after the written studies of Dr. John C. Merriam, in whose opinion they are more nearly related to the llamas (*Auchenia*) of South America than to the existing camels of the Old World. The giant cat as restored by Mr. Knight is purposely spotted so as not to imitate too closely the true lion (*Felis leo*) of southern Asia and of Africa

are those of the ancient bison (*Bison antiquus*); the remains of these two less intelligent animals are three times as numerous as those of the more intelligent species of horse, of which there are only about seventeen individuals. These three large quadrupeds—the camel, bison, and horse—are equally distinctive of the plains, savannahs, partly forested, and seasonally dry regions, but they were not equally apt to be deceived by the thin sheets of water covering the tar pools, because of their varying intelligence.

The Rancho-la-Brea yielded many fine skulls and materials for two mounted skeletons of *Camelops hesternus*, an animal approximating the Bactrian camel (*Camelus bactrianus*) but, according to J. C. Merriam, much nearer in relationship to the South American *Auchenia* (llama, vicuña). Matthew, however, regards *Camelops hesternus* as distinct from the existing llama and the true camel of Asia. This species of tylopod, also known in Kansas (*Camelops kansanus*), is a gigantic quadruped, towering in size over its Rancho-la-Brea companion. This companion, the ancient bison (*B. antiquus*), was first discovered in the Big Bone Lick beds of Kentucky. It is represented in the Los Angeles Museum by two skeletons and a large series of skulls; the horn cores, longer and relatively more slender, are set at right angles to the face, whereas in other species of bison the horns are more or less obtuse. Other and much rarer Herbivora are representatives of the existing prong-horn family of American antelope

known as *Capromeryx minor*, a genus also represented by a species (*C. furcifer*) of Hay Springs Lower Pleistocene beds of western Nebraska. The true pronghorn antelope (*Antilocapra*) is not present. Equally rare are traces of the existing true Virginia or white-tailed deer (*Odocoileus*), a forest-living animal. Rare, too, is the crest-toothed peccary (*Platygonus compressus*), a species larger than the existing peccaries, with sharply cross-crested grinding teeth, and limbs and feet more progressive in their adaptive running habit than in the existing peccary (*Dicotyles*).

BIRDS OF THE RANCHO-LA-BREA AND McKITTRICK TAR POOLS

The helpless mammals, foot-entangled in the tar pools, attracted and thereby lured to the same fate numerous species of birds of prey of the early Pleistocene period, and thus provide us with a fairly complete representation of this part of the avifauna, which has been analyzed by Merriam, Miller, and Wyman as belonging to thirty-two species and twenty-three genera:

BIRDS OF PREY

Catharista occidentalis, nearly related to living black vulture.
Cathartes aura, turkey vulture.
Cathartornis gracilis, extinct vulture of New World type.
Gymnogyps californicus, California vulture.
Sarcorhamphus clarki, extinct condor.
Teratornis merriami, extinct condor with very large bill.
Neophrontops americanus, extinct vulture of Old World type, resembling 'Pharaoh's chicken.'
Neogyps errans, apparently an extinct vulture of Old World type.
Elanus leucurus, white-tailed kite.
Circus hudsonius, marsh hawk.
Indeterminate species of *Circus*.
Buteo borealis, red-tailed hawk.
Indeterminate species of *Buteo*.
Archibuteo ferrugineus, ferruginous rough-legged hawk.
Aquila chrysaëtos, golden eagle.
Haliæetus leucocephalus, bald eagle
Geranoaëtus grinnelli, extinct buzzard-like eagle.
Geranoaëtus fragilis, extinct buzzard-like eagle.
Morphnus woodwardi, extinct harpy-like eagle.
Morphnus daggetti, extinct eagle, recalling secretary bird because of its long legs.
Falco peregrinus, peregrine falcon or duck hawk.
Falco mexicanus, prairie falcon.
Indeterminate species of *Falco*.
Falco sparverius, sparrow hawk.
Polyborus cheriway, Audubon's caracara
Small indeterminate species of *Polyborus*.
Tyto pratincola, barn owl.
Asio wilsonianus, long-eared owl.
Asio flammeus, short-eared owl.
Otus asio, screech owl.
Bubo virginianus, great horned owl.
Speotyto cunicularia, burrowing owl.

In the Rancho-la-Brea the extinct condors (*Teratornis* and *Sarcorhamphus*) dominate the other flesh-eating birds in size. There were six smaller species of vultures, three of which are now extinct, namely, the *Cathartornis* of New World type, and the *Neophrontops* and *Neogyps*, believed to be of Old World type. The kites, hawks, golden and bald eagles, falcons, sparrow hawks, and caracaras were chiefly of recent species, but there were three extinct eagles, two of buzzard-like type and a long-legged harpy eagle (*Morphnus daggetti*), recalling superficially the secretary bird of Africa. There were six species of owls, all of recent type. Most remarkable among the game birds (Gallinæ) was a large form (*Parapavo californicus*) inter-

mediate in character between the peacock (*Pavo*) and the ocellated turkey (*Agriocharis*). The game birds are also represented by the California quail and an indeterminate pheasant.

The total list of non-raptorial birds such as ducks and geese, herons and storks, cranes and rails, as determined by Loye Miller, is so remarkable that it deserves entering in full:

NON-RAPTORIAL BIRDS

PYGOPODES: DIVERS
Podilymbus podiceps, pied-billed grebe.

ANSERES: DUCKS AND GEESE
Anas platyrhynchos, mallard.
Chaulelasmus streperus, gadwall.
Mareca americana, American widgeon.
Nettion carolinense, green-winged teal.
Querquedula cyanoptera, cinnamon teal.
Spatula clypeata, shoveller.
Dafila acuta ?, pintail.
Marila americana, redhead.
Chen hyperboreus, snow goose, a small form.
Anser albifrons ?, white-fronted goose.
Branta canadensis, Canada goose.
Branta dickeyi, a gigantic goose, as large as a swan.

HERODIONES: STORKS AND HERONS
Mycteria americana, wood ibis.
Ciconia maltha, an extinct stork.
Jabiru mycteria, jabiru.
Ardea herodias, great blue heron.
Indeterminate heron, smaller than a night heron.

PALUDICOLÆ: CRANES AND RAILS
Grus canadensis, brown crane.
Rallus virginianus, Virginia rail.

LIMICOLÆ: SHORE BIRDS
Recurvirostra americana, American avocet.
Macrorhamphus griseus, dowitcher.
Totanus melanoleucus, greater yellowlegs.
Pelidna alpina, red-backed sandpiper.
Oxyechus vociferus, kildeer.

GALLINÆ: GAME BIRDS
Lophortyx californica, California quail.
Indeterminate pheasant.
Parapavo californicus, a large bird intermediate between peacock (*Pavo*) and ocellated turkey (*Agriocharis*).
Meleagris?, turkey.

COLUMBÆ: PIGEONS AND DOVES
Zenaidura macroura, mourning dove.

COCCYGES: CUCKOOS
Geococcyx californianus?, road-runner.
Neomorpha ?, probably a ground-cuckoo

PICI: WOODPECKERS
Colaptes cafer, flicker.

PASSERES: PERCHING BIRDS
Corvus brachyrhynchos, American crow.
Indeterminate species of *Corvus*.
Corvus corax, raven.
Sturnella neglecta, western meadowlark.
Pipilo, indeterminate species of towhee.
Petrochelidon lunifrons, cliff swallow.
Lanius ludovicianus, loggerhead shrike.
Several other indeterminate passerine birds.

The birds from the McKittrick asphalt—a region in Kern County, California, about 120 miles northwest of the La-Brea—as summarized by Loye Miller[1] are regarded as of somewhat more recent geologic age. In these pools were captured relatively few mammals, such as the dire wolf, the giant cat, the horse, the bison, the sloth, and the camel; and the great sabre-tooth of Rancho-la-Brea is entirely wanting. With this relative scarcity of mammals in McKittrick there is a notable scarcity of the large scavenging birds. The giant condor *Teratornis* is rare and none of the other great condors of the Rancho-la-Brea is present, although the golden eagle *Aquila chrysaëtos* is extremely abundant. In short, the raptorial list from McKittrick is a small one; the great mass of the McKittrick collections is composed of ducks, herons, cranes, storks, and shore birds, a fossil avifauna showing the greatest resemblance to that of Fossil Lake, Oregon, as described by Shufeldt. The distinctive fresh-water fauna suggests to the

[1] Loye Miller: "Avifauna of the McKittrick Pleistocene." Univ. of Cal. Publ. *Bull. Dept. Geol. Sci.*, Vol. 15, No. 9, pp. 307–326.

imagination a landscape made up of shallow, open, muddy-margined ponds interspersed with grasses or sedge—the ponds too shallow for gulls, pelicans, and other fish-eating birds, the mud and grass attracting shore birds, cranes, herons, ducks, and storks. The large peacock-turkey (*Parapavo*) so conspicuous at Rancho-la-Brea is entirely lacking. The census of groups for the McKittrick tar pools is substantially as follows:

Anserines: ducks and geese	33%
Limicolines: sandpipers, plovers	20%
Herons, storks, cranes	14%
Total water birds	67%
Golden eagles	28%
Other land birds, including additional raptorial species	5%
Total land birds	33%

This Rancho-la-Brea and McKittrick fauna has been reviewed by James P. Chapin with reference to the interesting problem of geographic origin and migration, a problem largely solved in the case of the American fossil mammals but still awaiting solution in the case of the rapidly migrating and less-known birds. Certain of the birds may well have accompanied the mammals in their great journeys toward the Rancho-la-Brea region from southern and northern Asia and from South America.

Certainly of south Asiatic origin is the giant mammoth (*Archidiskodon imperator*); it may possibly have been accompanied by the forerunners of the wood ibis (*Mycteria americana*), by the fossil peacock-turkey (*Parapavo californicus*) and the forebears of true turkeys (*Meleagris*), by the Old World vultures (*Neophrontops* and *Neogyps*), and by the ground cuckoos (*Neocoerphus*), a genus closely allied to *Carpococcyx* of southern Asia. Of north Asiatic or Holarctic and of North American origin may have been all the ducks and geese, herons and storks, cranes and rails, cuckoos, woodpeckers, and perching birds.

Probably of tropical American origin or affinity are seventeen species, including the New World vultures and giant condors (*Teratornis*)—in short, the majority of the vultures characteristic of South America are richly represented in the avifauna of Rancho-la-Brea. Chapin remarks that the American vultures, for example, must be of tropical American origin, for although in the early Pleistocene they evidently were well represented in California yet they had not crossed to Asia. The birds that can be proved of North American origin are few and those of possible South Asiatic origin still less numerous. There are also in the McKittrick and Rancho-la-Brea representatives of some groups of birds now so widely spread over the whole globe that their origin can scarcely be guessed. This fifth group is fairly cosmopolitan in nature; in it are a species of stork (*Ciconia*), rail (*Rallus*), avocet (*Recurvirostra*), white-tailed kite (*Elanus*), marsh hawk (*Circus*), peregrine and sparrow hawk (*Falco*), barn owl (*Tyto*), short-eared owl (*Asio*), screech owl (*Otus*), horned owl (*Bubo*), and cliff-swallow (*Petrochelidon*).

To summarize this story of the tar pools of early Quaternary time, we have every reason to believe that it is a nearly complete chapter in the prehistory of the Southwest. It reveals practically the entire large mammal and bird life of the period, and it is this fullness of life which renders the discovery unique in the history of palæontology.

Fig. 1.—Site of discovery of *Pithecanthropus* on the left bank of the Solo River, at Trinil, Java, indicated by a black cross. From the Report of the Selenka Trinil Expedition

Recent Studies on the Skull and Brain of Pithecanthropus

By J. H. McGREGOR
Research Associate in Human Anatomy

THE "Ape-man of Java," *Pithecanthropus erectus*, has occupied a preëminent position in the literature of human palæontology for more than thirty years; and the main facts regarding it and the history of its discovery at Trinil, Java, in 1891-92 by Dr. Eugene Dubois, as presented in dozens of books, technical and popular, have become almost common knowledge among scientifically informed persons. Doctor Dubois, who at the time of his famous discovery was a surgeon in the Dutch Colonial Military service, and is now professor of geology in the University of Amsterdam, published an illustrated quarto memoir in 1894, describing the calvarium, or top of the skull, the left femur, and two molar teeth. In September, 1895, he exhibited the remains at the International Zoölogical Congress at Leyden, where they were examined by numerous anatomists and palæontologists. The differences of opinion among these experts as to whether the fossils were human or simian, or an intermediate form, are notorious. Some held that they were the remains of an ape, more manlike than any hitherto discovered, others considered them human but extremely primitive, some regarded them as human, but merely pathological anomalies. However, the weight of opinion favored the view ably defended by Doctor Dubois, that the bones were those of a creature intermediate between the anthropoid apes and man—a real "missing link."

At the time of the Leyden meeting the cranial cavity was still filled with a very hard matrix. Later Doctor Dubois removed the greater part of this and made an endocranial cast, which he exhibited and discussed at the Fourth International Congress of Zoölogy, at Cambridge, England, in

1898. Measurements of the skull cavity at that time led him to calculate the encephalic volume at 855 cubic centimeters (an estimate which he has since increased, as discussed below), a very fair intermediate between the brain volume of the gorilla and man. In general, it may be said that the evidence adduced from these early studies seemed to confirm the "missing link" idea, though, as Doctor Dubois emphasized, this conception does not imply that Ape, *Pithecanthropus* and *Homo* form a linear series; the "link" may just as well be merely the middle one of three divergent branches.

While I have no intention of reviewing here the descriptive or critical literature of *Pithecanthropus*,—much of which is readily available, it may be as well to mention a few items of popular interest. When Doctor Dubois started from Holland for Java, he avowed his intention to find "the missing link." Naturally when he announced the fulfillment of the promise, surprise bordered upon incredulity —at first. The generic name *Pithecanthropus* (ape-man) had been proposed many years before by Ernst Hæckel for a hypothetical annectent creature, midway from ape to man, and was aptly applied by Doctor Dubois to the fossil which seemed to embody its realization; the specific name, *erectus*, refers to the upright posture and bipedal gait, which were to be inferred with certainty from the manlike femur. Doubts have often been expressed regarding the association of the skullcap and the femur, which were found some fifteen meters apart, some critics maintaining that the femur was truly human, the skull that of an enormous ape, probably a giant gibbon. It is quite true that the calvarium exhibits some striking points of likenesses in form to the skull of a gibbon, likenesses which have been fully indicated in great detail by Professor Dubois, but in his Cambridge paper in 1898, and also in his recent work published in 1924, he demonstrates the extreme improbability of the giant gibbon theory.

Until quite recently no additional data were available later than Doctor Dubois' contribution in 1898. In general, his early view of the midway status of *Pithecanthropus* was widely accepted. The giant gibbon theory had a few defenders, the most notable being Professor M. Boule, of Paris, and a number of the ablest authorities were disposed to place *Pithecanthropus* definitely in the human family. Sir Arthur Keith in 1911 expressed the opinion that the form might aptly be named *Homo javanensis*, though he does not mention this in his later writings, and Professor Osborn (1915) refers to it as "Trinil man." Duckworth suggested that the Heidelberg jaw, clearly human, and the Trinil calvarium might be complementary parts of two essentially similar types. Professor G. Elliot Smith, who carefully examined the endocranial cast at Cambridge in 1898, read a paper before the Royal Society in 1914, in which he maintained that, judged by its brain, *Pithecanthropus* must be considered a member of the human family, possessing the rudiments of language but probably not ancestral to any existing race.

In the summer of 1923 Professor Dubois invited President Osborn, of the American Museum of Natural History, to Holland to study the original fossils. Professor Osborn found it impossible at the time to accept the invitation, and kindly suggested that I go in his place (a suggestion for which I am deeply indebted to

him) as I had devoted considerable study to the literature of *Pithecanthropus*. This arrangement met with gracious assent from Professor Dubois, and I accordingly went to Holland, where every facility was given to me for the study of these world-famous fossils, which are housed in the attractive Teyler Museum in Haarlem. A large series of stereophotographs was made of all the remains, which, in addition to the well-known calvarium, femur, and two upper molars, include a first left lower premolar, found later at Trinil and probably from the same individual, and a fragment of a lower jaw, found some twenty-four miles from Trinil, very probably from a second individual of the same species. There is also a very perfect endocranial cast, a most important document, which tells even more about the creature than does the outside of the skull.

The study of these specimens yields abundant new data, the more significant features of which I shall try to indicate briefly. Since my study of the material in 1923, Professor Dubois has published a contribution of great value, "On the Principal Characters of the Cranium and the Brain, the Mandible and the Teeth of *Pithecanthropus Erectus*," together with a second paper containing eleven splendid plates illustrating all these parts in heliotype.[1] Professor Dubois has studied these fossils so thoroughly and critically, and from so many aspects, that it is practically impossible to touch any question relating to *Pithecanthropus*, the pros and cons of which he has not exhaustively considered. In the following pages I shall draw freely from his new work, as well as his earlier memoir, and also from my own notes and photographs. As I believe Professor Dubois is about to publish a new study of the femur, the treatment of that bone will be omitted here, and I shall limit my discussion to the skull, including the encephalon, the jaws, and the teeth.

Taking first the calvarium or skullcap: the external size and form of this fragment have long been familiar through the commercial casts to be seen in many museums, with the greatly depressed crown, the excessively low and narrow forehead, the prominent supraorbital torus and the slope of the nuchal surface of the occipital region, where the great neck muscles are inserted. All these suggest the anthropoid ape, and especially the gibbon. The narrowness of the forehead just posterior to the orbital region, and the marked width of the postero-lateral region, a condition known as trigonocephaly, may be due, in Professor Dubois' opinion, to premature closure of the frontal suture. The median ridge on the forehead strongly suggests this condition, though it should be made plain that there is no considerable deformity of the cranium, nothing really pathological, and nothing to lend the slightest support to the absurd suggestion, made many years ago, that it might be the skull of an idiot. It may be remarked in passing that a very similar condition of the frontal bone is apparent in the recently discovered Rhodesian skull. Useful as is the cast of the skullcap, many important features are discernible only in the actual fossil, and study of casts has led to some erroneous conclusions by various authors. In several regions, as may be seen in the original skull, the outer surface of the bone has been eroded, in some places quite deeply.

[1] Koninklijke Akademie van Wetenschappen te Amsterdam, Proceedings, Vol. XXVII, Nos. 3, 4, 5 and 6.

Fig. 2.—The calvarium of *Pithecanthropus*, seen from above. The narrow postorbital region and wide posterior parietal region are clearly shown. The bregma or meeting point of coronal and sagittal sutures also shows distinctly. The roughness of much of the surface is due to erosion. This photograph is reproduced (reduced) from Professor Dubois, with his kind permission. The dotted line has been added by Professor McGregor to indicate approximately the outline of the anterior parts of the skull before erosion. Two-thirds natural size

by sulphuric acid, formed, as Professor Dubois has explained, by decomposition of pyrite in the volcanic tufa in which the skull was embedded. In the anterior parietal region on each side of the sagittal suture, the apparent slight concavity is thus partly the result of loss of the outer lamina of bone. The anterior border of the great supra-orbital torus, and, to a less extent, the region of the inion at the back of the skull, have also suffered similar loss, diminishing the length of the cranium to the extent of 3.5 millimeters or more, indicating that the maximum length of the cranium before injury was about 184 millimeters, instead of 180.5 which it now measures. The deep pit

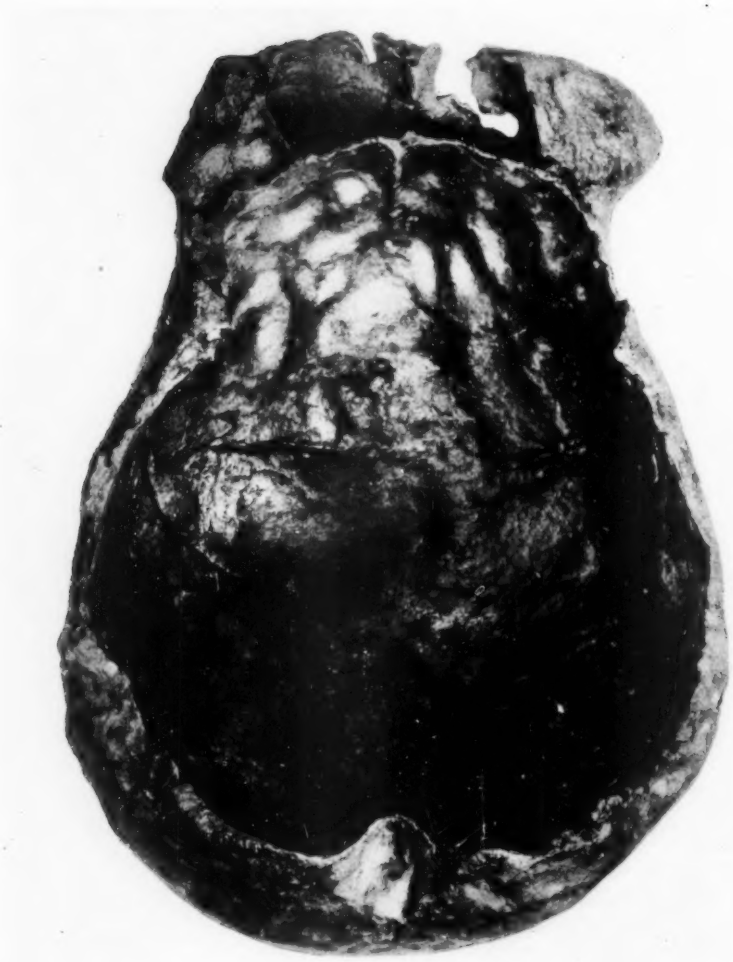


Fig. 3.—The calvarium of *Pithecanthropus* seen from below. The capacious frontal sinuses are clearly shown. The thinness of the margin of fracture in the occipital region is due to erosion of the outer lamina of bone. A small amount of matrix was still in the posterior part of the brain cavity when this photograph was made. Two-thirds natural size. From Dubois, by permission

in the nuchal surface of the occipital, which has always been a feature of interest, is also in part due to external erosion. At the broken edge in the occipital region only the inner table of the bone is left, forming a thin blade-like border and indicating that, in the uninjured state, the occipital slope was still more nearly vertical and more apelike than would be supposed from the cast. In the figures showing the norma verticalis and norma lateralis, the dotted line indicates approximately the natural outline before erosion. The maximum width of the skull is 131 millimeters, which, allowing for surface erosion, gives a cranial index of 71.5, thus placing

Pithecanthropus well within the dolichocephalic, or long-headed, category. This long-headedness, however, is largely due to the projection of the supraorbital torus, containing the greatly inflated frontal sinus, well shown in the illustrations, and hence the cranial index in this case has little significance in comparisons with simian and human skulls. The index would be very different in a young *Pithecanthropus*, before the frontal sinus had attained its development.

There has been much confusion in the past regarding the position of the bregma (the point of union of sagittal and coronal sutures) in *Pithecanthropus*, but in the actual fossil it is clearly observable and coincides with the slightly elevated boss on the top of the skull, shown in the figures. It is rather far posterior so that the frontal bone presents a longer arc in the median plane than the parietal (according to Professor Dubois' identification of the lambda), unlike the condition in *Homo*, where the increased size of the brain necessitates an expansion of the parietal arc.

A notable feature of the external surface of the cranium is the slight development (though perhaps partly obscured by erosion) and the wide separation (about 85 millimeters) of the temporal lines on the sides of the skull, which mark the limit of attachment of the temporal muscles of the mandible. This indicates that the jaws were relatively small, as compared with those of the great apes, an inference fully corroborated by the condition of the mandibular fragment attributed to *Pithecanthropus*, described farther on. The weak development of these temporal lines, and the general absence of crests for muscular attachment, has led some palæontologists to regard the specimen as a female, but in the absence of material for comparison the sex must remain in doubt. It is certain, however, that the skull is that of an adult, as fully attested by the condition of the sutures, and the great expansion of the frontal sinuses.

Considering the external form of the skull, Professor Dubois is inclined to regard it, "On the whole not human; nor is it a transition of any type of manlike apes to the human type. The agreement with the anthropoid cranial type, particularly that of the small gibbon species of the genus *Hylobates* may, on the other hand, be called perfect, taking into consideration the inevitable deviation in the proportions in consequence of the ratio of the volume of the brain and the eye varying with the increasing bulk and cephalization." The deviation from the human condition is especially marked in the posterior region, where the strongly developed occipital torus, and the more nearly vertical slope of the nuchal plane indicate "that the head was not equipoised on the spinal column as in modern man, but was carried by strong nuchal muscles and ligaments, as in the apes. It is not to be seen by the structure of the skull that *Pithecanthropus* deserves the name of *erectus* assigned to it on account of the features of the femur." Professor Dubois makes it clear, however, that he does not consider it the skull of an anthropoid ape, and that the resemblance to the gibbon is not sufficient to warrant its classification among the Hylobatidae, the gibbon family.

Of greater importance than the outer surface of the cranium, as yielding criteria of relationships, is the inner surface. Fortunately in the present case this is practically perfect. When Doctor Dubois exhibited an

endocranial cast at the International Zoölogical Congress in Cambridge in 1898, a small portion of the matrix was still in place so that the cast was incomplete. Later he skilfully removed this remnant of rock to the last particle, using a dental drill and

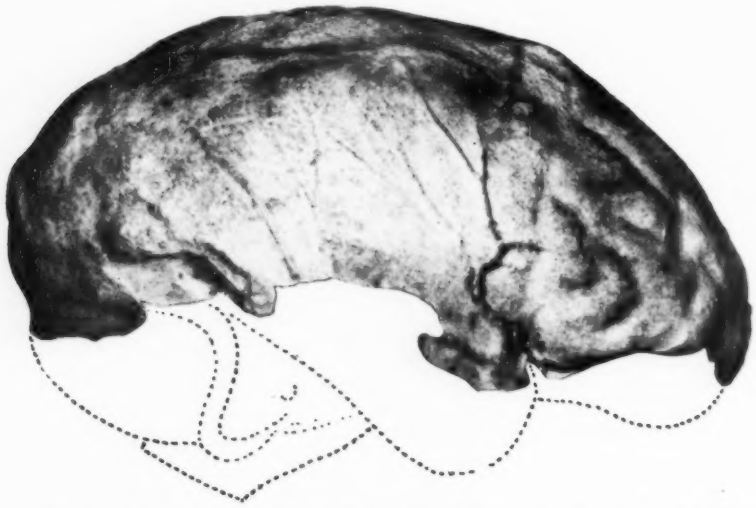


Fig. 4.—The endocranial cast of *Pithecanthropus* seen from the right side. The convolutions of the frontal lobe, which present an essentially human pattern, are well shown. This photograph is taken from Professor Dubois' recent contribution, and reproduced with his kind permission. The dotted outline of the missing portion has been added by Professor McGregor as an aid to the general reader. Two-thirds natural size

devoting many days of most painstaking care to the work. The result amply justifies the arduous labor. The erosion which is so pronounced on the outer surface of the skull is here entirely absent, and the surface details of the cast are virtually as perfect as if it had been made from a fresh skull. It is particularly fortunate that the line of fracture is sufficiently low to preserve many features of the greatest importance. On the right side enough of the skull wall remains in the region of the pterion to show a crest indicating a marked separation of frontal and temporal lobes of the brain, as in man, at the anterior end of the Sylvian fissure, and just anterior to this a small portion of the lateral part of the frontal floor is preserved, showing that the lower frontal region was decidedly more manlike than apelike. The impressions of frontal convolutions on the skull are exceptionally clear for a primate—possibly indicating that this part of the brain was somewhat constricted by abnormally early union of the frontal bones, a condition also indicated on the outside of the skull as described above. An especially important feature seen in the cast is the marked development of the lower frontal convolution, the region in man of motor control of the speech organs, the so-called Broca's convolution. Opinion differs as to the value of such evidence as criterion of specific function, but this region of the brain of *Pithecanthropus* resembles so closely the corresponding part of the brain of *Homo* that one can scarcely escape

Fig. 5.—The endocranial cast of *Pithecanthropus*, seen from above. This photograph shows the remarkably clear impressions of the frontal convolutions, and the general human form of the brain as seen in the norma verticalis. Two-thirds natural size. From Dubois (1924) by permission

the conclusion that the creature must have possessed some rudiments of speech. But speech requires more than mere control of the motor mechanism; there must also be appreciation and discernment of vocal symbols. Now, it happens that one of the most notable features of the cast in question is the great expansion of that portion of the temporal lobe (the middle temporal convolution) concerned in man with this function, the so-called auditory speech center. The development of this area is clearly seen in the photograph of the endocranial cast viewed from above. Professor G. Elliot Smith, the eminent neuro-anatomist of London, in calling attention to this very point in the endocranial cast, says: "This can have only one meaning, the fact that in the earliest known member of the

A B C

Fig. 6.—Endocranial casts of a large male gorilla (A), *Pithecanthropus* restored (B), and Rhodesian man (C). The three casts were photographed together to show the relative sizes. The volumes of the three are A, 580 c.c; B, 940 c.c; and C, 1300 c.c. The reader can readily compare *Pithecanthropus* with the ape and man. The lower part of the *Pithecanthropus* cast is restored

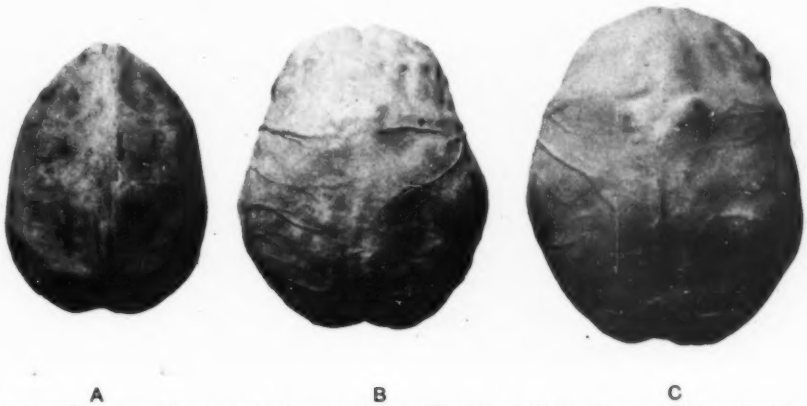
Human Family there was a sudden expansion of the acoustic territory for the appreciation of some sort of speech." In the opinion of Professor Dubois the great breadth of the temporal region is due rather to the constriction of the frontal area above mentioned, than to spontaneous expansion of the former. However, the concomitant hominoid development of these two regions concerned with motor and auditory phases of articulate speech certainly appears to be significant.

Seen from above, the form of the brain appears rather human than apelike, but in side view the extremely low crown differentiates it from even the lowest types of man. Professor Elliot Smith emphasizes the fact that the regions in which *Pithecanthropus* exhibits the most striking deficiency are precisely those regions which attain their full elaboration latest in the cerebral development of the human child, namely, the prefrontal and parietal areas. The inferior temporal

A B C

Fig. 7.—Endocranial casts of a large male gorilla (A), *Pithecanthropus* (restored) (B), and the Gibraltar example (restored) of the Neanderthal race (C). The volumes of the three are A. 580 c.c., B. 940 c.c., and C. 1280 c.c.; thus the gorilla's brain has three-fifths the volume of that of *Pithecanthropus*, and the latter almost exactly three-fourths that of the Gibraltar brain

area is a third region similarly belated in human ontogeny, but as this is lacking in the cast, the slight development of this area in *Pithecanthropus* is chiefly inferential, though there is some actual evidence, on the right side of the cast, that such deficiency was present. Professor Smith's studies of the endocranial casts of *Eoanthropus*, Rhodesian man, and various specimens of Neanderthal man, also demonstrate the deficiency of these regions, although in much less degree than in *Pithecanthropus*. As might be expected, the sulcus lunatus or "Affenspalte" which is present in all the apes, and frequently in primitive and underdeveloped human brains, is well marked in *Pithecanthropus*. Fortunately, the cast shows a portion of the cerebellar surface and, especially on the right side, the transverse sinus. We have thus a clear picture of the occipital region of the encephalon, which approximates the anthropoid ape in the very slight overhang of the occipital lobe of the cerebrum. Figure 6 in which endocranial casts of gorilla, *Pithecanthropus*, and Rhodesian man are photographed together, illustrates this feature clearly. Comparing figure 7 it will be seen that in this feature the Gibraltar brain (Neanderthal race) appears to be more primitive and more like *Pithecanthropus* than the brain of Rhodesian man.



A B C

Fig. 8.—Endocranial casts of a large male gorilla (A), *Pithecanthropus* (B), and Rhodesian man (C), photographed together to show relative size and form. The volumes are A. 580 c.c., B. 940 c.c., and C. 1300 c.c. *Pithecanthropus* resembles the human far more than the ape in the form of the frontal lobes of the brain

A question of great interest, in connection with the possible human relationship of *Pithecanthropus*, is the *size* of the brain. Professor Dubois, from his recent studies, has increased his former estimate of 855 cubic centimeters to 900. His calculations were made by measuring the capacity of the calvarium to a certain line with water, then calculating the volume of the remaining portion by careful morphological comparison with corresponding parts of "skulls of apes which resemble *Pithecanthropus* as much as possible." *Hylobates agilis* appears to be the form chiefly used in the comparison, with due allowance for the relatively greater encroachment of the orbits upon the frontal lobes and other morphological differ-

ences. It appears to me that there is a more reliable method of calculation, that is to complete the endocranial cast by modeling the missing portions by careful comparison with endocranial casts of apes and men. I have attempted this, and the result is the only portion of the present paper for which originality can be claimed. Endocranial casts of *Hylobates*, orang, chimpanzee, gorilla, Rhodesian man, and the Neanderthal specimens from Gibraltar, Chapelle-aux-Saints and La Quina, together with modern human types, were used in the comparison. Some years ago I attempted to reconstruct approximately the size and form of the brain of *Pithecanthropus* by lining a piece-mold of the skull with clay of the estimated thickness of the cranial wall, then making a cast of the interior and modeling the missing parts. In London, in 1921, before Professor Dubois' endocranial cast was available, I made a second attempt, having at that time the invaluable aid and advice of Professor Elliot Smith. The result was a fair approximation to the actual condition later revealed in the cast. The benefit of Professor Smith's counsel in that tentative restoration is now embodied

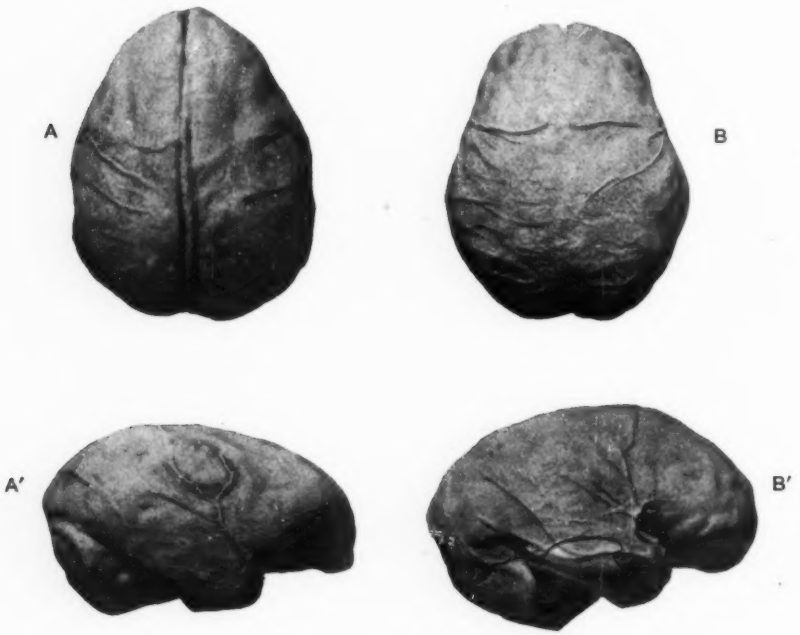
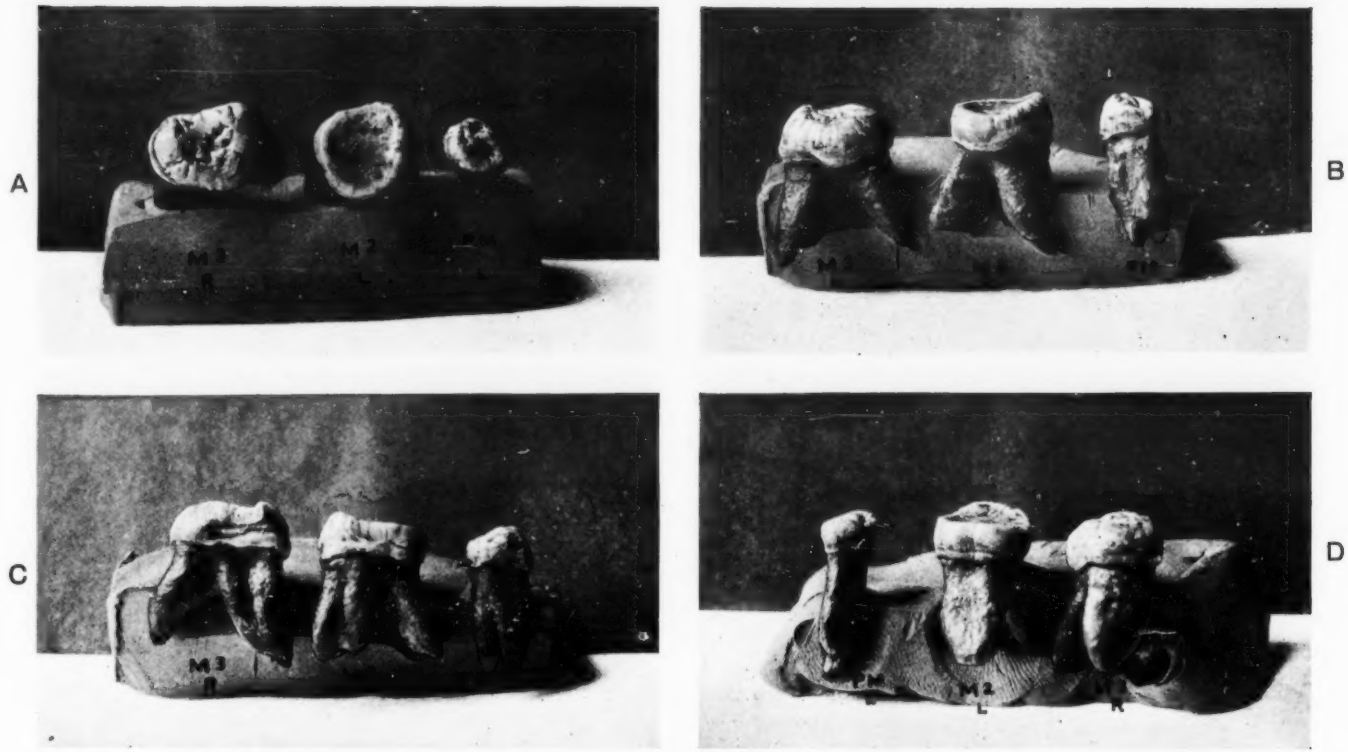


Fig. 9.—Endocranial casts of *Hylobates*, a gibbon (A and A′) and *Pithecanthropus* (B and B′), top and side views. To facilitate comparison the photographs of both are here reproduced about the same size, though the brain of *Pithecanthropus* is many times larger than the other. In the top views the frontal region of the gibbon is seen to be relatively far smaller. It lacks also the localized expansion of the temporal region,—the area concerned in man with appreciation of speech symbols or words,—which is conspicuously developed in *Pithecanthropus*. In side view *Pithecanthropus* is far more manlike, though the occipital region shows strong resemblance to the apes

in the restored part of the present model, but I wish to make it clear that as at the present writing he has not seen the new restoration he is in no sense responsible for any defects it may possess. The present non-technical article is not the place for a discussion of the reasons for the morphological details of the restoration which I hope to publish elsewhere in the near future. It may be stated, however, that the parts preserved give ample warrant, in the light of comparison, for every important feature of the restored portions. On the whole, as is obvious from the photographs, the hominoid features outweigh the pithecoid very decidedly. The frontal region, deficient as it is in the prefrontal area, is far more manlike than apelike both in general form and in the pattern of the convolutions. The deep incisure separating frontal and temporal lobe is also a human character. The probable size of the petrous space between temporal lobe and cerebellum was carefully considered in relation to these parts of the brain, and also to the underlying bone. The form of the cerebellum and its forward extent in lateral view, and the anterior position of the downward turn of the transverse sinus, are all human features, in contrast to the nearly vertical apelike slope of the occipital surface. It should be made clear that the restored part, like the actual cast, does not represent the brain surface, but the inside surface of the skull, or the outside of the entire encephalon, including the meninges, blood-sinuses, etc. The probable position if important foramina—optic foramen, superior orbital fissure, the foramina rotundum, ovale, and spinosum, the carotoid arteries and transverse sinuses, have all been calculated as carefully as possible, partly to make sure that all portions of the restoration would be mutually consistent throughout, thus insuring greater accuracy, and also to serve as a basis for a restoration of the entire cranium which is now under way, involving cranio-cerebral topographical correlations.

Now as to the endocranial capacity of *Pithecanthropus*, as arrived at by this laborious method. By water displacement the volume of the cast as restored is found to be 940 cubic centimeters. Of course there is some possible error. It may be that the cerebellum should be a shade smaller; perhaps the temporal lobe ought to be a trifle more voluminous, but it seems unlikely that the deviation can be more than 15 to 20 cubic centimeters in either direction, and I believe 940 cubic centimeters to be a close approximation to the truth. This falls just within the normal minimum of modern man. Sir W. Turner found a female Australian skull of 930 cubic centimeters capacity, and a number of others under 1000 have been measured, while the largest gorilla barely exceeds 600. The very large gorilla cast here represented measures 580 c.c., almost exactly three-fifths the volume of *Pithecanthropus*. The Gibraltar cast (a female Neanderthal) as restored measures 1280. The Rhodesian man, as restored by Mr. F. O. Barlow of the British Museum, 1300 cubic centimeters. These are the two human endocranial casts here figured. Thus *Pithecanthropus*, with nearly three-fourths the encephalic volume of these ancient and primitive humans, and equalling some of the more lowly modern types, seems, as regards brain size, as well as brain form, to belong within the human family. In form of brain it is distinctly closer to the low-



THE THREE TEETH OF *PITHECANTHROPUS*, FOUND AT TRINIL

Fig. 10.—P M is the anterior left lower premolar. The tip of the inner (lingual) branch of the divided root is broken off. Its probable form is indicated by a dotted outline in B and C. M 2 is the left second upper molar, the crown of which is worn to a smooth, slightly concave surface. The facet of contact with the third molar is shown in B, the contact facet with the first molar in C. M 3 is the right third upper molar, or wisdom tooth. A.—Crown view. B.—Posterior (distal) view. C.—Anterior (mesial) view. D.—Inner (lingual) view. About natural size. Photographed from the original by J. H. McGregor

crowned Neanderthal and Rhodesian than to any normal modern type. In view of the fact that the external skull form so strongly suggests the gibbon, I have thought it might be of interest to present photographs showing an endocranial cast of *Hylobates* side by side with that of *Pithecanthropus*, both reproduced about the same size to facilitate comparison. As seen from above, and also from the side, the differences, even ignoring the restored part of *Pithecanthropus*, are more striking than would be supposed from a similar comparison of the external skull form, and the deviations of *Pithecanthropus* from *Hylobates* are all in the direction of man. On the whole, it may be stated that the brain of *Pithecanthropus*, in size and in form, is distinctly closer to that of man than to that of any ape. The general brain form is, perhaps, rather more like *Hylobates* than gorilla, but judging from the hominoid convolution pattern, as indicated in the frontal region, the cerebral surface was certainly closer to gorilla than to gibbon, since the gorilla in this respect is by far the more manlike of the two apes.

Professor Dubois' original memoir in 1894 contained a description of two upper molar teeth, a left second and right third, the former considerably worn. They are characterized by widely divergent roots and extremely large crowns, especially wide in transverse (bucco-lingual) diameter. The third molar, or wisdom tooth, shows a reduction of the cusps and a peculiar contraction and wrinkling of the crown, the wrinkles suggesting the teeth of the orang and resembling the condition observed in various Neanderthal and Australian teeth. Able palæontologists have disagreed as to whether the teeth were predominantly human, or apelike. As recently as 1923 Mr. Gerrit S. Miller, Jr., of the U. S. National Museum, studying casts of teeth without considering their possible relation to the skull, believed them to be the teeth of "A now extinct Javan great ape, resembling the orang of Sumatra and Borneo." But Sir Arthur Keith, Gregory, Hellman, and others find important similarity to human molars. Doubt has been expressed as to the association of the teeth with the skull, but as the calvarium was found not more than a meter distant from the third molar, and in the same level, there can be practically no question as to their being parts of the same individual. I feel quite certain, also, from study of the original teeth, that the two molars belong to the same creature.

After Doctor Dubois' return from Java, a third tooth was found in the Trinil excavation, a left anterior lower premolar. This is a particularly important tooth, as it yields indubitable evidence regarding the upper canine. The tooth is small, and quite human, and had it been found alone there would have been no question as to its humanness. The root is forked at the tip, or rather there are two roots united except at the extremity, a primitive condition occasionally seen in the corresponding tooth of man, and an important human character is that the two branches of the root, buccal and lingual, are opposite, not obliquely placed as in the corresponding tooth of the apes. Facets of wear show the occlusion of this tooth with the upper canine and first premolar, and a contact area on its mesial border indicates its close proximity to the lower canine. This tooth clears up one highly important point hitherto doubtful. It

proves that the upper canine, which is always slightly larger than the lower, was small and hominoid. In all the anthropoid apes the first lower premolar is elongated and enlarged in adaptation to a shearing occlusion

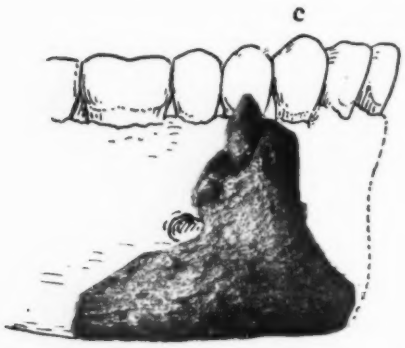


Fig. 11.—Photograph of the manidbular fragment from Kedung Brubus, with pen and ink restoration of the chin region and anterior teeth. The fully preserved root is that of the anterior premolar. The canine is marked C. The restoration extends only to the symphysial line which is dotted. The small size of the anterior teeth and the nearly vertical chin are clearly shown. Three-quarters front view. Natural size

with the tusklike upper canine, consequently *Pithecanthropus*, with small premolars and canines, must have been manlike in possessing a short dental arch. Of course the question may be raised whether the premolar belongs to the same individual, or even the same species, as the molars. As to this it may be stated that the condition of fossilization, the color and texture of crown and roots, etc., which are apparent in the original teeth, together with the absence of any remains of other large primates, render it highly probable that the three teeth are all members of the same denture.

The view that *Pithecanthropus* possessed a manlike dental arch receives trong confirmation from another source. This is a most important piece of evidence—a fragment of a lower jaw. It was found by Doctor Dubois in 1890, nearly a year earlier than his discovery of the Trinil wisdom tooth. The site of discovery of the jaw was at Kedung Brubus, about twenty-four miles east-southeast of Trinil, and in the same geological level which yielded the Trinil fossils. The mandibular fragment was briefly described by Doctor Dubois in 1891 as a human fossil "of another and probably lower type" than the known European Pleistocene races (Neanderthal *et al.*) Later study and comparison with *Pithecanthropus*, especially with the lower premolar, have convinced Professor Dubois that the jaw fragment is really from another example of the same genus. The part preserved, which is from the right side of the chin region, contains the entire root of the first premolar tooth, part of the canine alveolus and the extremity of the root of that tooth; also the alveolus of the second premolar and the anterior border of the mental foramen, sufficient to convey a fairly authentic picture of the form of the chin region. It proves, for one thing, that the chin was practically vertical, but lacking any pronounced mental eminence,—in short, somewhat like the Neanderthal chin, and quite different from that of any ape; though, as Professor Dubois observes, it is approximated somewhat by the chin region of *Hylobates*. A unique feature is the great extent of the digastric fossa, which is bounded externally by a rather sharp inferior margin. It is difficult to imagine the functional significance of this peculiar condition. The body of the mandible is shallow—only 30 millimeters in height in front of the first premolar. The root of the first

premolar is quite flat, measured mesiodistally, and the root canal can be seen to divide into buccal and lingual branches, corresponding exactly to the bifurcation of the root in the first premolar from Trinil. The canine alveolus containing the extremity of the root demonstrates the small size of that tooth, thus completely confirming the inference drawn from the Trinil premolar that the canines must be small and manlike. Before the publication of the data, photographs, casts, etc., regarding the Trinil premolar and the mandible fragment from Kedung Brubus, it was naturally supposed that the anterior portion of the dental arch and the chin region would show a development essentially intermediate between the anthropoid apes and man (with perhaps a closer approximation to the human), in correlation with the assumption that the cranium represented a transitional form, or at least an exceedingly apelike type of man. Study of the endocranial cast, however, has necessitated a revision of this view, since the diagnostic features of cranium and brain indicate that *Pithecanthropus* is a humble member of the human family. The hominoid characters of the jaws, chin, and teeth, are quite compatible with this latter conception, though the small size of the anterior teeth as compared with the molars may seem to indicate some morphological disharmony. However, since the Piltdown discovery, we have come to realize that nature may sometimes ignore our preconceived notions of harmonious correlation.

In 1914 I essayed a restoration of the skull of *Pithecanthropus*, having only the commercial cast of the exterior of the calvarium and the writings of Professor Dubois and others to guide the work. A little later a flesh restoration was modeled on the reconstructed skull. The new evidence regarding the teeth and chin convinces me that these restorations were somewhat too prognathus, therefore, in the light of new knowledge, a revised restoration of the skull, which will be more authoritative, has been commenced. I hope before long to publish elsewhere a more technical treatment of the skull and brain of this most important fossil which, even though it now seems to be a member of the human family, is still the most apelike type of man, and more than any other known form merits the appellation of "missing link." But this does not necessarily imply that *Pithecanthropus* is a direct ancestor of any true *Homo*, fossil or living. It may represent a side twig of the hominoid branch, a great uncle rather than a grand fatherof man. Despite certain simian features the evidence, on the whole leads as Professor Dubois states "to the conclusion that *Pithecanthropus* should be considered as a member, but a distinct genus, of the family of the Hominidæ."

In conclusion, it is a pleasure to acknowledge my indebtedness to Professor Dubois, who not only kindly afforded me every facility for the study of the material and for making numerous stereophotographs, but devoted two entire days to aiding me in the work, and who finally has granted permission to copy figures from his valuable memoir published in 1924.

DAUBENTONS' BAT: A EUROPEAN SPECIES

Thorburn, the great British artist-naturalist, has given some excellent illustrations of bats in his work on *British Mammals*. Through the courtesy of Longmans, Green and Company, NATURAL HISTORY is able to show an example of Mr Thorburn's skill in depicting the bat in flight. See text for description of the flight mechanism of bats

The Bat[1]

A MUCH MALIGNED AND LITTLE UNDERSTOOD MAMMAL

By H. E. ANTHONY
Associate Curator of Mammals of the Western Hemisphere

TO the mind of the average person the bat is a creature of disagreeable attributes, striving to entangle itself in women's hair, carrying unwelcome insect life, and possessing features of both mammal and bird, so that one is bewildered what to call the creature. There is so little truth in what currently passes as fact with regard to bats, these animals are so interesting upon acquaintance, and they have so few bad qualities to discourage a closer acquaintance, that it seems timely to set forth some of the authentic data. Inquiries received at the Museum show that there is a fairly widespread interest in bats, and that people would like to know more about them.

From time immemorial the bat has been placed in the category of evil creatures, along with the owl, the black cat, and others. Because of its nocturnal habit the bat naturally would be associated in primitive and ignorant minds with the dread of darkness. Folklore and legend show us that this has been the case. It has been said that the bat-motif is well demonstrated in the crude pottery of the Arawaks, who lived in the West Indies in pre-Columbian times. It is doubtless to be found in the figured designs of many prehistoric and early peoples.

When witchcraft was in vogue the bat enjoyed an unsought notoriety. Not only was it reputed to be a creature of the devil, but certain parts of its anatomy served for charms and poisons. For example, witches used, among other things,

> Eye of newt, and toe of frog,
> Wool of bat, and tongue of dog,

to fill their cauldron on the heath and work the ruin of Macbeth. Possibly the following negro incantation is an indirect version of that in *Macbeth*:

> Pizen insides in de pot
> Wid de sarpints steamin' hot.
> Add de hin' laigs uv a toad
> Hoppin' on a ha'nted road.
> Wuhms an' bats an' lizuhds stir
> An' a piece uv 'possum fur.
> Little bit of el'phunt's nose
> An' a witch's middle toes.
> Bubble, bubble, trouble brof.
> Skeer de ebil speerits off.

An old Natural History of 1744 states that the tongue and the heart of a bat are said to be poisonous. Many statements and beliefs of this sort, which seem amusing to us today, can be traced in the early writings.

In the Bible the bat is made the associate of the mole, presumably because both are dwellers in darkness and of devious and little understood habits:

> In that day a man shall cast his idols of silver, and his idols of gold, which they made each one for himself to worship, to the moles and to the bats. Isaiah ii, 20.

In Leviticus and in Deuteronomy, the bat is listed among the forbidden animals:

> And the stork, and the heron after her kind, and the lapwing, and the bat.

Note that the bat is here associated with the birds!

[1]Photographs by the author

And so on down the ages the bat has been under a handicap, treated by man about as Æsop tells us the bat was treated by the other animals, neither as a bird nor a mammal, but a creature by itself, avoiding observation by day and coming forth only in the darkness.

As a matter of fact, the bat is a perfectly typical mammal, bearing its young alive and nursing them at the breast, the same as a mouse. The general resemblance of small bats to mice has found expression in the word for bat in the various languages, such as the French *Chauve-souris*, the Spanish *Murcielago*, and the German *Fledermaus*. In the British West Indies the negroes call it "rat-bat," because they use the word bat for butterflies.

One of the common bats of Jamaica, *Chilonycteris parnellii*. Bats habitually hang head downward when at rest, and the sharp claws on the hind feet are admirably adapted for clinging

Bats are seemingly vicious little creatures and a captive invariably bites when caught. The small species can do little harm to the hand, scarcely puncturing the skin, but the larger species very soon impart a respect for their prowess. I rather suspect that the bat disposition is more easily irritated than that of most mammals, but since our observations of bats are made under circumstances which must be necessarily very disturbing to them, the creatures can scarcely be expected to display a calm, unruffled temperament.

Bats are among the most ancient of mammals. To judge from the great number of existing species and subspecies, belonging to many families, the bats as an order must have originated at a very remote period. We know that bats, apparently as well developed as we see them today, were living in the Paleocene, since fossil records have been discovered in that horizon in America. In Europe, fossils of bats have been found in the Eocene. We are certain, then, that the first flying ancestors of the bats must have lived long, long before these specialized and highly developed forms found in the Eocene, and the creatures we know as bats must have been capable of flight for millions upon millions of years.

No other order of mammals shows such great diversity of structure or so many highly specialized features. The modern classification, based upon these differences in structure, recognizes no less than 263 species and subspecies (taken from Miller's *List of North American Recent Mammals*) in North and Central America. This number is probably only a little more than one-tenth of the total number of varieties found in the world. Doubtless the complete list of bats exceeds 2,000 different forms.

Bats differ from all other mammals in their ability to maintain sustained flight. Other mammals, such as the flying squirrel, have the power to glide, but bats alone are able to propel themselves through the air. To accomplish this the bodily structure of the bat has undergone profound modifications. The forelimb has lost its primitive, primary function of quadrupedal locomotion and has become a framework and a support for a flying membrane. The digits have lengthened enormously, the thumb is short, but the four fingers are so long that they constitute in the combined length of metacarpals and phalanges the longest bony structure in the entire skeleton. The third finger is the longest and about equals in length the total length of head and body. Only the thumb has a claw (in our New World bats), the four fingers are clawless, and their long, slender bones are employed to spread and hold in position the tough membrane of the wing.

The wing stretches back from the shoulder, elbow, and forearm to the hind leg, and in many species the membrane continues across from leg to leg and includes the tail. The membrane which is supported by the two legs, is called the interfemoral membrane and is of great importance in controlling the direction of flight, acting more or less as a rudder and not being a part of the propelling mechanism.

No warm-blooded animal has so completely mastered the mysteries of flight as the bat. We have yet much to learn of the distances bats can fly; it is improbable that any bat can fly as far or as fast as a plover, a falcon, or a swift, for example, but for aërial gymnastics and perfectly controlled flight there is no bird to match the insect-catching bats. These bats can check their flight instantly, change direction in any plane, and have a certainty of movement that shows perfect mastery. Birds which catch insects while in full flight, the swifts, swallows, and nighthawks, for instance, have a very large gape to the mouth and can scoop up their prey. Bats, on the contrary, do not have such an excessive gape, and the mouth opening is only slightly larger in proportion to the body than it is in comparable terrestrial mammals. In order to capture a rapidly moving insect the bat therefore must be certain of its aim, for its jaws are no dragnet. The flight of the bat reflects this precision of aim in its sharp angles and abrupt zigzags, quite unlike the more rounded, evenly flowing passage of a swallow.

The flight mechanism of the bird is composed of a series of vanes,—the feathers,—and there is always an opportunity for the escape of air between adjacent feathers. This quantity of air varies with different types of bird wings, but there is no bird wing which is air-tight throughout its entire feather expanse. The flight mechanism of the bat is essentially an air-tight membrane thrown into changing curves and shifting planes by the muscles, and the pattern of the curves and the position of the planes are controlled by the elongated fingers and the hind legs. The primaries of the bird are held and directed at their forward ends only; the shape of the feather is fixed, except as it bends to air pressure. The bat membrane is secured, not only along its forward margin but at either side and to the rear as well. This explains, to some extent, the mechanics of the extremely erratic flight of the bat; the cause for the irregular course this mammal traces against the twi-

light sky is explained by the fact that the bat takes its prey where it finds it and goes to that spot in a straight line.

The science of aëronautics has sought deep into the mysteries of bird-flight in the search for data to build aëroplanes. A much closer analogy may be drawn between the bat and the aëroplane, but unfortunately the very intimate details of bat-flight are yet to be discovered. It is known from the structure of bats that there are many variations in the fundamental elements of the flight mechanism. For example, the shoulder girdle, which takes up the thrust of the humerus and consequently is the principal joint in the wing, articulates with the upper bone of the wing in several different fashions depending on the species. These differences in articulation, these variations in the joint, must certainly be reflected in varying freedom of wing movement. In other words, some bats may be able to give a powerful wing beat through a very wide arc, while others can thrust through only a limited arc. All of the bats of the northern United States, the Vespertilionidæ, a very highly developed group, fly with a motion perhaps best described as fluttering, and possess large, broad wing membranes and ample, interfemoral membranes. In the tropical regions we find another highly specialized group of bats, the Molossidæ, or free-tailed bats, possessing very narrow wing membranes and a narrower interfemoral membrane. The free-tailed bats ride through the air with a rapid wing beat, at a distance much resembling their feathered cousins, the swifts.

Bats have developed to fill each possible economic niche available to a flying mammal. The greater number of species are insect-eating and find an abundance of food in their own medium, the air. Many others feed solely on fruit and must visit trees. The large fruit bats or flying foxes of the Old World belong in this category, which also includes many of the smaller New World bats as well, members of a distinct suborder, however. The American fruit-eating bats devour a great variety of the softer, pulpy fruits, from bananas to ripe coffee berries. Often they feed on the fruit where they find it; sometimes they pick it in passing and carry it away to eat in caves or other favored spots

Bats of more predatory types have been evolved and may be considered truly carnivorous. A genus of bats in America is known to be fish-eating, and there is a similar group with like appetites in the Old World. Indeed, the Asiatic *Megaderma lyra* is known to feed on fish, frogs, and bats smaller than itself. It has been observed on the wing, carrying another bat, sucking its blood as it flew, and later devouring the body, crunching the bones in true carnivorous fashion.

The most highly specialized of all the bats, from the point of view of food, is the true vampire bat, of the family Desmodontidæ, found only in America. The vampire feeds on fluid blood and it is difficult to understand how it could survive on any other food. Its teeth are reduced in number, the fewest in all the bats, and are adapted for puncturing the skin; they would be ill-suited for anything else. The intestines are short and the entire alimentary tract is modified for a highly concentrated, fluid food such as blood. Vampires have been long and unfavorably known. The early Spanish explorers were bitten by them, and so intense was the reaction among the pioneers in the New World that

they suspected most of the tropical bats, whether they were blood-suckers or not. Any bat with an ugly face, and this is an all-embracing term, was dubbed a vampire, and we find that even today the name is loosely used to include bats of irreproachable habits. While we know some of the outstanding features in the life-history of the vampire, we are yet woefully ignorant of the complete story. We know that this bat preys upon almost any blooded creature available, from birds to man; that its bites may be fatal to its prey when the animal is small and weakened by too heavy draining of blood; and that its manner of attack is so subtle that a man does not realize he is bitten, as a rule, until he awakens in the morning.

The following is an extract from *Ulloa's Voyage*, 1772:

> Bats are very common all over the country; but Carthagena is infested with such multitudes of them, that after sun-set, when they begin to fly, they may, without any hyperbole, be said to cover the streets like clouds. They are the most dextrous bleeders both of men and cattle; for the inhabitants being obliged, by the excessive heats, to leave open the doors and windows of the chambers where they sleep, the bats get in, and if they happen to find the foot of any one bare, they insinuate their tooth into a vein, with all the art of the most expert surgeon, sucking the blood till they are satiated, and withdraw their tooth; after which the blood flows out at the orifice. I have been assured, by persons of the strictest veracity, that such an accident has happened to them; and that, had they not providentially awaked soon, their sleep would have been their passage into eternity; they having lost so large a quantity of blood, as hardly to be able to bind up the orifice. The reason why the puncture is not felt is (besides the great precaution with which it is made) attributed to the gentle and refreshing agitation of the air by the bat's wings, hindering the person from feeling this slight puncture by throwing him into a deeper sleep.

Aside from the fact that the true vampire bites both man and cattle, most of the above is overdrawn and inexact, but it serves as a typical statement of the times.

So much yet remains to be discovered in the life-histories of the various bats that no other field in mammalogy offers prospects of equal attraction to the observer. There are no less than fifty separate, distinct dental-formulæ among the bats; that is to say, there are that many different ways in which the teeth of bats are arranged, varying from a total of twenty teeth up to a total of thirty-eight teeth. There must be differences in habit and behavior, more or less marked, correlated with these differences in tooth arrangement, but of most of these we are ignorant.

Bats hibernate or migrate when they live in regions where severe winters cut off the food supply. In the northern United States, in winter, one may occasionally find the big brown bat, *Eptesicus fuscus*, hiding dormant in some dark, sheltered nook. Or in the fall, red bats, *Nycteris borealis*, may be seen flying southward in the daytime, and are frequently mistaken for birds.

Most species of bats have but a single young one at a birth, but a few species, such as the red bat, have from two to four. The young are carried about by the mother until they are almost full grown; and it speaks well for the bat's powers of flight that the female can, in the case of the red bat, carry much more than her own weight in youngsters and still hawk successfully for insects.

Contrary to some of the common beliefs, bats have good eyes, good in the sense that they are perfectly developed, although often proportionally rather small. The expression

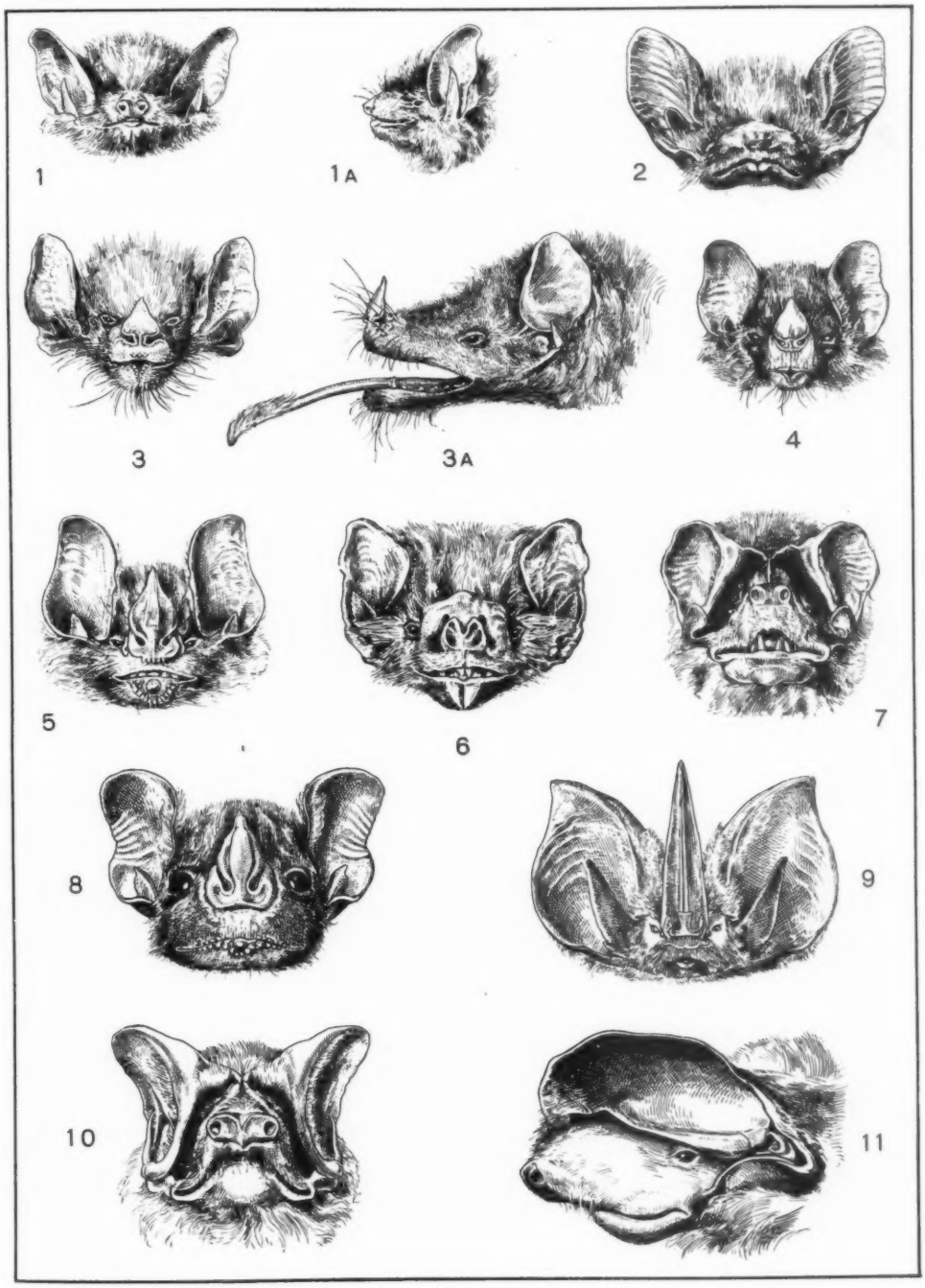
"blind as a bat" has little foundation in fact, although many of our commoner species of bats behave in a bewildered fashion if brought into bright daylight, and may thus give the impression of faulty sight. But it is quite likely that bats depend very little upon the visual sense, either for securing prey or for finding their way about.

Bats frequent caverns the deepest recesses of which are never visited by a single ray of the weakest light, and hang, night after night, on the same small cornice or ledge with all the assurance of birds going to roost in the daylight. On dark nights the small eyes of the insectivorous bats can be of little value in finding the smallest of their prey. About the close of the eighteenth century, the Italian naturalist and experimenter, Spallanzani, performed his classical experiments with bats and discovered that the power of controlled and directed flight was independent of eyesight. Spallanzani closed the eyes of bats with varnish and liberated the creatures in rooms crossed and recrossed with fine, silk threads. The blinded bats flew freely back and forth between the threads, avoiding contact with the obstructions, and absolutely certain of direction. Later workers have reflected somewhat upon the comprehensive claims of Spallanzani, but confirm his statement in principle. The bats can find their way about, when blinded, because of the great development of a tactile sense or perhaps more than tactile, a pressure or vibration sense responsive beyond anything known in other mammals. These flying creatures may also possess a sixth sense, that of direction.

The peculiar outgrowths upon the nose, face, and ears of bats indicate to us the presence of special sensory apparatus. A clear understanding of the functions of all of these structures waits upon future study, but it is not improbable that the nerve endings here, and perhaps some in the volar membranes as well, record the faintest differences in air pressure and air vibration, so that the bat is aware of physical obstacles before it reaches them. Hahn, whose experiments with bats are the basis of a most interesting report, states that the inner ear is the seat of these special sense organs of perception. The well-developed ears hint that they are an important source of information when insect prey is sought. The flight of insects must be audible to bats at a considerable distance. The bat's ear is tuned to the higher sound frequencies, such as those of a tiny insect's wing, and bat voices are correspondingly high-pitched, so high, in fact, that some people cannot hear them.

As has already been stated bats have been flying mammals for so long a time that their forelimb has lost its early function as a leg, and the hind leg bends in a reversed direction. In general, bats walk very poorly on the ground, supporting themselves on the wrists and the hind feet, but there are a few species which scamper about almost as readily as mice in spite of this handicap. These are the free-tailed bats, and doubtless the restricted flying membranes of these bats permit more freedom of motion of the limbs. Strange as it may seem, bats are capable swimmers and make good progress in calm water.

These winged mammals, like many other mammals, may be hosts for numerous parasites. The parasites may resemble forms which are troublesome to humans, but the bat does not



FACES OF NEW-WORLD BATS

1–1A, *Myotis*. 2, *Peropteryx*. 3–3A, *Anoura*. 4, *Glossophaga*. 5, *Hemiderma*. 6, *Desmodus*, the vampire. 7, *Molossus*. 8, *Artibeus*. 9, *Lonchorhina*. 10, *Tadarida*. 11, *Eumops*

BATS HANGING FROM THE CEILING OF A CAVE IN PANAMA

This flash-light photograph was taken with the camera pointing directly upward at the cave ceiling, where hundreds of bats were clustered. A few bats were flying across the field of the lens and caused the indistinct blurs, most conspicuous at the top of the picture. An instant after the flash-light was fired the air teemed with bats

carry any insect pest which would leave the bat in preference for man. The parasites on the bat are all, for the most part, peculiar species found only on bats, and never troublesome in human habitations.

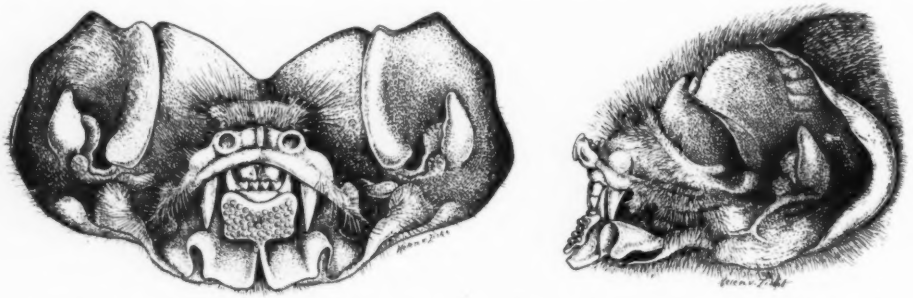
Bats have but few dangerous enemies and so their numbers are limited only by the food supply. Owls catch them, and in Cuba, it is said, the boa lies in wait at the mouth of caves and catches them occasionally. In Africa there is a bat-eating hawk, but this is a rare species. Cats may catch a bat now and then. In the north bats are never very abundant, probably living conditions are not very favorable; but in tropical America they are more numerous in species and in individuals than any other mammal. Unless one has had unusual opportunities for observation, he can scarcely imagine the spectacle of a well-tenanted bat cave in the West Indies or on the tropical mainland.

In Jamaica, for example, there are limestone caves of vast extent, some of them half a mile long, others three, four, or five miles long. These caves are the homes of great assemblages of bats. When a man visits the caves with a light, entering cautiously, only a few disturbed creatures will be seen flying about. It may be possible to note dark masses of drowsy bats clinging to the ceilings or packed into crevices and crannies. And if specimens were taken from each mass of individuals it would be discovered that each group contained only members of a single species, and these would be all of one sex. But let a shot be fired in the cave, and all is changed before the short-lived echoes cease. Confusion follows hard on pandemonium, and a tempest of wildly whirling forms bursts into the cave. Bats by the thousands pitch down from overhead and the noise of terrified wings sounds like a gusty wind or a tropical rain storm approaching through the tree tops. High-pitched, strident squeaks voice the alarm, and the bewildered bats dash everywhere. It is seldom that the native, who has served as a guide to the cave and perhaps entered out of curiosity, will stand his ground when enveloped in a cloud of tens of thousands of these leathery wings which billows around his head. The old, superstitious fear proves too great, and he will seek the exit in a panic second only to that of the bats.

I have stood at dusk in one of the old, rambling buildings of Spanish architecture in the West Indies and watched the bats pour forth. The building was not being used, and here, there, and everywhere dilapidation had opened up ample crevices for bat habitation. Back of the loosened boards, behind the shutters, under the eaves, there was a boiling and seething of hidden life. The scuffling of tiny feet over the wood, the fine, wiry squeaking of impatient voices as those behind crowded the foremost, and the sense of bustling energy being set free showed that, for the bats, the day was just beginning. Out of the various nooks the bats were trickling in thin streams which flowed through the rooms to mingle in the center court or patio. Here the converging lines began to circle about in a counter-clockwise direction, mounting higher and higher on each revolution. The arrivals increased in number rapidly until the court took on the appearance of a great whirlpool of bats, a maelstrom of swiftly circling forms which flowed upward and spilled over the top of the building as the creatures set off on their hunting.

It is not easy to estimate the number

of individuals in one of the large caves, but it is certain that the census runs beyond the thousands, quite surely that it is well into the tens of thousands, and perhaps it would be little exaggeration to place it into the hundreds of thousands. It may require an hour or more for the cave to empty itself at dusk in a continuous stream of hurrying forms. In some of these caverns, where generations upon generations of owls have had their abode and levied tribute upon the bats, the bones of the victims lie piled on the floor, mingled with the remains of birds, reptiles, and rodents. These bone deposits may be measured in tons, and bear mute testimony to the long occupation of the cave, the great number of bats frequenting it, and the persistent toll taken by the owls.



These two views, full-face and profile, show the physiognomy of the leaf-chinned bat, *Mormoops blainvillii*, a West Indian species. This bat is one of the most complexly ornamented forms known

As another index to the great bat population in favored caves, mention might be made of the great guano deposits formed by bat droppings. Vernon Bailey, in the *National Geographic Magazine* for September, 1925, estimates that 100,000 tons of bat guano have been removed from the Carlsbad Caverns of New Mexico since man has worked the deposits.

Bats have considerable economic importance, just how considerable it is impossible in our present state of knowledge to say. Bats destroy myriads of insects, many of which are injurious to man's health and interests. In San Antonio, Texas, municipal bat-roosts have been erected to encourage bats to take up residence there to aid in freeing the city of mosquitoes and other insect pests. But competent observers have stated that such a bat population has little real control over the mosquitoes. Bat guano has a high value as a fertilizer. The fruit-eating bats transport seeds and serve as a factor in the distribution of plant life. In some parts of the Old World the larger bats are an important article of diet on the native menu.

Finally, there is very little that can be said against bats, especially our North American species. The blood-sucking vampire never reaches the United States, and none of our species are injurious to crops. Bats do not wilfully entangle themselves in the hair of women; they do not carry insect life which lives on man; their diabolical physiognomies are their own concern and no proof of relationship to the evil one; and while they choose the dark hours for their activities, it is not because they have anything that they would hide from us.

Extracts from the Diary of Martin Johnson

THE Johnsons have been established at Lake Paradise about eighteen months, carrying on their work of making life histories of African wild life along the lines described in NATURAL HISTORY for May-June, 1924. The following extracts from Johnson's diary will give some idea of the thrills and heartaches that are sure to fall to their lot in this fascinating undertaking. We shall get infinitely more of it all from the story of "The African Elephant"—a film that is now completed and will soon reach New York. Johnson is enthusaistic over it, which means that it is the best he has done. Better than Johnson's best means pretty close to the ideal.

—CARL E. AKELEY.

"OSA and I are all keyed up and excited over our wonderful elephant films. It may seem queer that we started right out after elephants instead of the picture 'Songa the Tale Bearer.' But you see the elephants kept bothering me all the time. They seemed to beg to be photographed. As elephants interest us more than any other animal in the world, we could not help going right after them, and it would have meant traveling long distances to get the tribes necessary for 'Songa the Tale Bearer.'

"As a matter of fact, 'Songa' has been in the back of my head all the time. I continually photograph natives whenever I find them, but I have not succeeded in getting the proper sequence to make up the completed feature. While I now have an elephant film that I would give anything to see the first night it is shown to the public—but of course I would be off here making other films. I would like to see the audience, for I want to watch their expressions when they see elephants so big that they will seem to walk right out of the screen, although I wonder if they will ever appreciate how almost every scene is playing with death. So far I have not made a single scene from a blind, but have been right in the open with the elephants, Osa standing to one side with the still camera, Saunderson, Boculy, and Bukari with their guns sighted on the elephants every second. Then when they 'get' us they start forward, but we make such a racket by yelling that almost always they run away. On our last trip, only a few days ago, nine elephants came for us three times, then turned back. On the last charge they kept coming and we had to knock down the leader four times before she would stop. Then she and the others ran away. I did not get the actual knocking down as my film ran out and I was loading, but I got the first two charges as they came within twenty yards of us each time before they turned, and now that I have developed it, I think it will prove the greatest wild animal film ever made by any one—just 200 feet, but the most valuable 200 feet I have ever made.

"And I wonder what the audience will do when a big bull lashes his trunk and comes for us seven times, backs off and comes again, then loses his nerve and runs away, each time coming so close that the aperture will show only his head. And I wonder what they will do when they see a baby elephant, a few days old, getting its dinner from its mother; a baby elephant that falls in a hole and scrambles out; another baby that runs in and out between its mother's legs as she walks along; and a mammoth mother rhino that, with her baby, comes within forty feet of

LAKE PARADISE

Surrounding Lake Paradise in every direction for hundreds of miles there is nothing but desert. A couple of our houses can be seen across the corner of the lake

us and stands undecided whether to charge or go—and goes.

"We have demonstrated how to save the lives of elephants and rhino when they are deciding to charge. We yell and make all the noise possible and with the one exception they have lost their nerve and run.

"As soon as I have finished developing in a few days, I will start assembling and getting the film ready for the market. Boculy has wandered off into the forest and I am expecting to have him back any day. Then, as I know he will do, he will come back excited, telling of elephants in a good photographic place and doing something wonderful. Then off I must go, for what can I do? Its the most wonderful and exciting thing in the world to photograph elephants. Of course, when I have this elephant film finished, I will go after lions and rhino and buffalo and the plains game, but I will always be making elephant films. I now have the satisfaction of knowing that I have a film that will be wonderful from the museum standpoint, for it shows almost everything elephants do, and I have them in every age, from a few days old to so old that they can scarcely carry their tusks."

* * *

"We sent the boys and the camels on ahead while Osa, Saunderson, and I climbed a hill to get a good look at the country. As we came down the cook came running up, all out of breath, saying that he had gone off by himself and had run into an elephant. So we hurried after him. I nearly forgot about Saunderson. He had gone down the other side of the hill and we could not find him, so Osa and I and the camera boys, who always stay with us (never mind where the rest of the safari goes), found the elephant in a little donga, feeding. We made a detour to get the wind right and when we came up to where he had been a few minutes before, he had disappeared. In fifteen minutes we found him again, but he seemed to vanish before we could get up to him. This happened three times and we had begun to think he was a spook. Osa named him 'Houdini' because he was so clever at disappearing. But we finally came up to him and made some fine pictures as he was feeding. Now we were doing a foolish thing. Saunderson was not with us and Boculy had wandered off ahead of the safari. This left only Bukari to guard us while we made pictures.

"'Houdini' then left his feeding and came toward us, but turned about when twenty feet away, went to a fair-sized tree and tried to pull it down with his trunk, but the tree bent and would not break. So he used his brains and pulled it down as far as he could with his trunk, then placed his tusks over the tree and held it while he reached up and got a better hold higher up with his trunk. He then pulled as far as he could, placed his tusks on it again, and so got another hold higher up. This time the tree snapped and he pulled it down to the ground with his trunk. He spent about thirty minutes feeding from it, selecting the tender young buds at the ends of the limbs.

When he had eaten all he wanted he walked around the tree and came directly toward us. I now had all the movies I wanted and told Osa to take her gun while I used the Graflex, and with my gun bearer standing right beside me I got several fine stills.

"'Houdini' came to within less than fifteen yards and saw us. He was moving slowly but when he saw us he

Surrounding Lake Paradise in every direction for hundreds of miles there is nothing but desert. A couple of our houses can be seen across the corner of the lake
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stopped so short that he swayed. His ears went out and he put his trunk out to try to get our wind. Then he slowly backed, turned and walked deliberately away. . . He was not angry and he was not afraid. Living on the game reserve all his life he had probably never been shot at and was not timid. Up to the time he saw us he gave the impression of being half asleep, although his eyes were wide open. In feeding he felt with his trunk, as though he was not seeing what he was doing. But when he saw us, he quickly became wide awake.

"We were in an absolutely open place without a tree. Had he taken a notion to come he would have been very dangerous. But we did not think of this until afterwards.

"We then packed up and continued towards Tembu Pass, where we were to camp. Just before we got there we saw Suko, Mrs. Johnson's boy, come running to us. He said elephants were right near the pass. . . I hurried to climb a rock and saw a big bull and a small bull walking along slowly in the open. I told my boys to follow and we scrambled along the rocky ridge at the top of the Pass until we came to a sloping rock leading down to the ground. Here I set up my cameras and in a few minutes the elephants were about twenty-five yards below me, drinking at a mud pool that was under a ledge, so I could not photograph them. But soon they came out and stood still in an open bit where the light was fine. I ground off a couple of hundred feet, and while I was reloading they saw us. I can't figure out, even now, what made the big bull so angry, but he was furious. Just as I got my "Akeley" loaded he came for the rock full speed. He tried to climb it but could not. He went back about ten yards and stood blowing air out of his trunk. He swayed from side to side. He pawed up the earth and lashed the air with his trunk. Then he came for the rock again but could not get up. All the time I was getting 'movies' and Osa was getting 'stills.' Osa, seeing that he could not get up the rock, ran down closer. The elephant then turned and ran away into the bush, with the other one following. But the big fellow stopped several times and looked back. I have a hunch that he would not have been so furious if we had been down on the level ground with him, for it must have been that he could not make us out on the rock.

"Great rejoicing at camp last night. All night long elephants could be heard trumpeting in the valleys near-by."

* * *

"In the evening after dinner Osa, with Bukari, climbed a ten-foot rock after agreeing on signals. . . she was to give one whistle, repeated at intervals, if a rhino was coming in front of us, two, if one came to the left, three at the right, and four whistles if one came up behind us. Saunderson and I lay down in the sand about twelve feet from the flash-light lamps, without anything around us for protection. Mosquitoes were bad, but with Osa watching over the country with glasses we did not need to be very quiet, so we had a good time scratching. About ten o'clock Osa gave one whistle; I raised up and with my glasses saw a rhino coming right down our path toward us. We lay as quietly as possible but the rhino got our scent just a few feet short of the place I wanted him; he gave a start and began to run, but I took a chance and closed the electrical contact that made

the flash. I forgot to close my eyes as the flash went off, so I was blinded for about three minutes. Saunderson knew I was blinded so he gave me reports; he had remembered to close his eyes. He told me the rhino had run away, he had stopped, he was coming back, he was going away again, etc. When I could see once more, I reloaded the flash lamps, put in new plates, and we lay down again. The rhino by this time had started down the trail again, but he was suspicious this time, stopped when thirty feet too far away, pawed up the ground and snorted. . . Do you know it is not a pleasant sound to have a big rhino snorting at you while you are lying in the sand not over forty-five feet away? As the ground had a slight rise at this point, it seemed that the rhino was towering directly above us. We had our guns at hand and I had the flash push-button ready. I resolved to get a flash if he charged, shooting after the flash if it was necessary. But he turned and walked away a few yards and stood snorting there, then went away a little farther. He tried to go around us to get to the water, but we could not stand for that since he would get our wind very strong and be sure to come for us, so we stood up and threw stones at him. He ran about a hundred yards and stood there for half an hour, until we saw two more rhinos coming toward us . . a mother and half-grown 'toto.' They would have come right down our trail, but the first rhino challenged them and they turned off the trail and went for him. He stood his ground and the two stopped about fifteen feet from him, all three with their tails in the air, snorting and pawing the sand. They circled about each other. For thirty minutes they kept this up; but as they gradually came closer together they stopped being so angry and finally seemed to rub noses. I am sure the first rhino told the other two about the queer thing down the trail, for all three made a wide detour and we let them go on to water. They finished drinking, detoured again, and started away as two more came along. The usual snorting and pawing started all over once more, until they had satisfied each other that all was right. Then the two new ones left our trail and Blame! if they didn't go clear around to water, like the first three who by this time had gone away.

"This went on until about midnight; Osa was kept busy whistling until she stopped in despair; there were so many rhino about us and others coming and going that she could not keep track of them. She had no need to, for Saunderson and I were busy watching that none came too close. About one o'clock a mother and toto had been to drink and came up behind us. We threw stones at them and they ran back, but shortly came on again, and we had to throw more stones.

"At one time we counted ten rhino in plain sight, with others that we could hear at water and off among the rocks.

"At two o'clock a giraffe came within fifty feet of the cameras but its long neck allowed it to see us too plainly and it went away. A bunch of bush pigs came along single file, but they, too, saw the cameras. Some zebra came close, then went around. It was so light, the moon was nearly full, that the cameras showed up too plainly. Right here I decided the best time to make flash lights would be during the dark of the moon when the stars would give us enough light, reflecting on the

sand, to see the game, but the animals would not be so likely to see our apparatus."

* * *

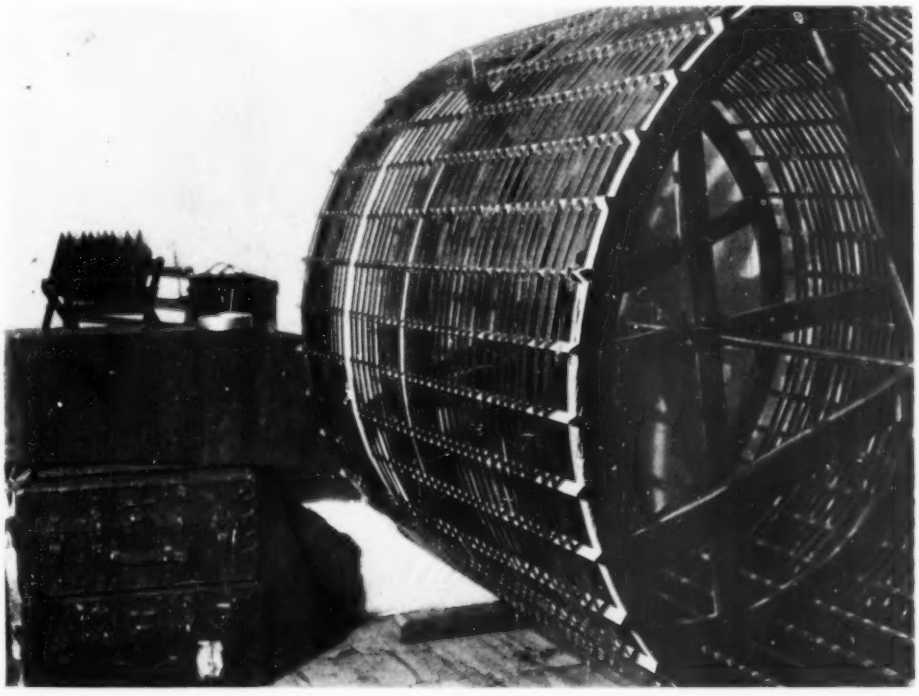
"Broke camp and we were on our way at daylight yesterday, a most beautiful safari along a dry river bed between two mountains. Game tracks and spoor everywhere but over a week old. When we stopped at noon we came upon a Samburu tribe moving into new country. They had some fifty camels and a hundred goats. About fifty people in the bunch; they were a wild looking lot and the women cried when I took their pictures. They did not dare run away because they had to hold the camels, but they were so frightened that we tried to ease their minds by giving the women each a handful of sugar. We left them to go their way and we went ours. The Samburu said they had seen no elephants for days. Poor Boculy was very downcast. About four o'clock we had to go through a narrow pass, not over fifty feet wide, between a large rocky hill and a larger mountain. On the other side I told the safari to stop in the shade of the rocks while the cameras cooled off, the carrying cases were almost too hot to touch. I then walked around the rock to see what I could see, and saw it. I ran face to face with a big bull elephant. He was walking slowly along, coming in my direction. I was less than twenty yards away but as I was hugging the rock the elephant did not see me. I slid into a crack between two rocks and he stopped to feed from a small tree. I gently slipped out and went around another rock, and hurried for my cameras. I got them back and set them up on a rock about five feet high at a place where the elephant was likely to come, and he did, just as I was ready for him. I made about two hundred feet of fine film; perfect light and a beautiful setting. Osa made four good stills, then he saw us and ran off into the bush. I packed up and went back to where the safari was waiting, very well pleased. I asked for Boculy but no one knew where he was. We were just starting out again when he came up, very downhearted, and took his place at the head of the safari. I was full of pep after getting the picture and I started to ask him questions about the elephant. Then he pricked up his ears and wanted to know what elephant. He had gone to another hill to look over the country and had not known about my good luck. I told him about it and in a few minutes he was all grins. About that time, another big bull elephant walked across the road in front of us, but so close that he saw us and went on into the bush, with his tail in the air. I managed to get a good picture of him as he came out in an open place and made for the hills."

* * *

"Boculy was on top of a nasty rock about two hundred feet high. He motioned for us to come up, which we did. Once on top I saw the elephant about half a mile away and I was mad because it was dangerous to take all my delicate cameras and apparatus over the rocks, and unnecessary. I am afraid I scolded Boculy more than he deserved, but he never said a word, although I could see from his face that he was furious. We climbed down and went after the elephant and I set up in a fine, open space. The elephant was feeding from a big tree and I started making films. I forgot to say that Osa was exhausted and we had left her with a pair of binoculars

on the top of the rock were Boculy had us climb up.

"In a few minutes the elephant started coming in our direction but saw us when within thirty yards. He returned to the tree and stood there a few minutes and then came toward us for us once more. He had his head up in the peculiar way elephants have when they are angry. He did this four times. All this while I was getting priceless film. The fourth time we 'got his goat' and he ran away, but he stopped several times and faced us



Drying drum and a few of my film trunks built on the fireless cooker idea

again, this time very curiously, in little goose steps. When within fifteen yards he started circling about us, and then with his tail in the air he went across a small donga. We followed. He stopped in the bushes and then came out toward us again. He lashed his tail and his trunk and then stamped the ground. He seemed to make up his mind to charge and he would come several feet, stop and come on again. When fourteen yards from us (we measured afterwards) he turned and ran back, then whirled and came before he finally was lost in the bushes. I did not get a single still picture but I am sure I got the most exciting elephant film ever made.

"When we got back we found that Osa had been crying. Through the glasses she had seen another elephant throwing water over itself from a water hole. He then came in the direction where we were making pictures. He saw us photographing the other elephant and he seemed about ready to charge. In fact, he went into the bushes near us and Osa was afraid he

would get us before we saw him. As a matter of fact, we had been so busy with the one that we had not seen the other."

* * *

". . . But the mules carrying water were lost and I sent Saunderson back on a mule to find them. I then climbed a tree to look over the country. I saw one elephant a mile away but it was too late to go after him. About six o'clock a big rhino came running full speed under my tree and continued on into the forest. Twenty minutes afterward Saunderson came limping in afoot. He had run into the rhino; his mule threw him into a dead tree. The mule made off back to the lake and the rhino was the one I had seen running. Saunderson is all skinned up and his clothing torn.

"This morning we took cameras and boys and started to a water hole an hour away; nothing there but lots of elephants using it. We went on for half an hour and found two elephants asleep in a small donga. Made some fine pictures of them but we got too close and frightened them. They ran up the side of the steep donga and I got a fine film of them scrambling out. We followed them and I caught them as they slowly moved down another small donga. Then they "got" us again and ran back to the bigger donga. Just then, as I was photographing the elephants, ten fine greater kudu came walking along on the other side of the donga. They were just in time, as I was all set up and I got a fine picture. They saw us after fifteen minutes and all crowded upon a small ant hill and I got a fine group, all looking at us. They were very tame and I made a better kudu picture then I ever hoped to get.

"We started back to camp and I made another picture of a female elephant coming up the donga toward us. She was very good in stopping at little trees and feeding. Just before we reached camp another big bull elephant came out of the forest and stood about three hundred yards from camp, throwing earth over himself. Got another good picture. Here in one day I made over a thousand feet of fine film that more than makes up for the days when we got nothing."

* * *

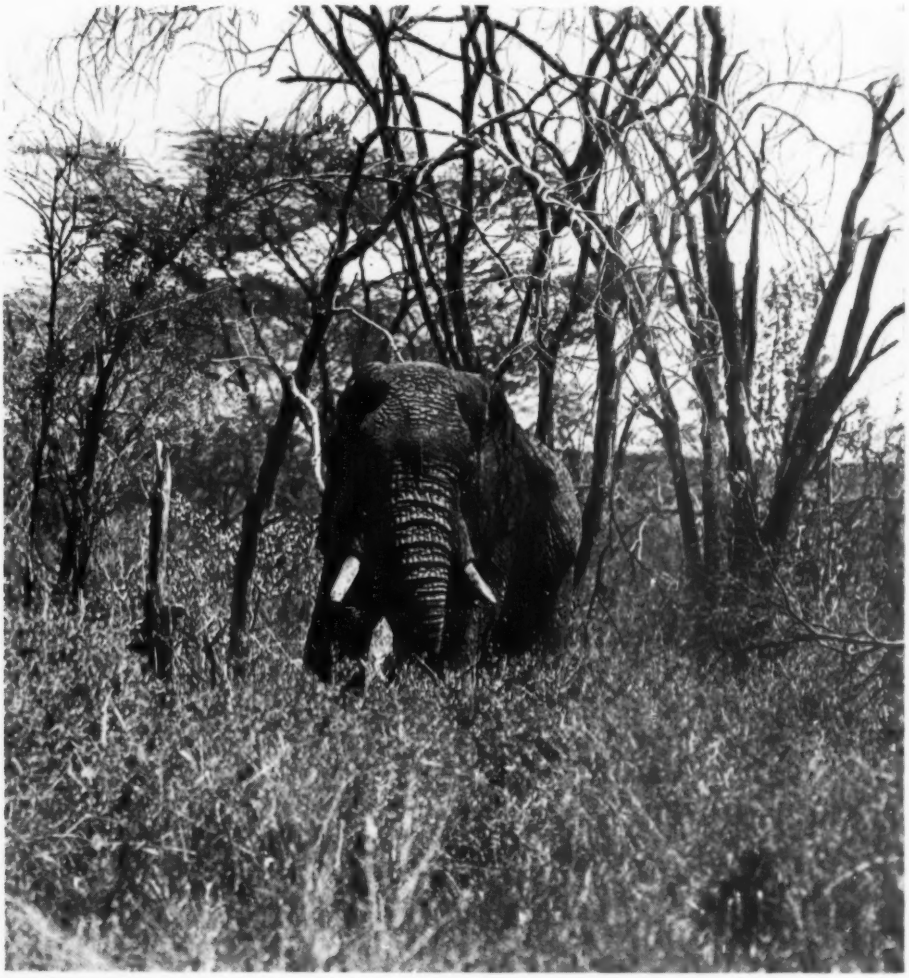
It might be interesting to know just what boys accompany me each day for camera work.—2 camera bearers; 1 tripod bearer (he carries 2 tripods); 1 boy who carries the lens case with different lenses in it; 1 boy carrying the Press Graflex with the tripod for it; 1 boy carrying a case of loaded film magazines; 1 boy carrying two cases of loaded plate holders; 1 boy carrying 4×5 Graflex with tripod; 1 boy carrying a case of odds and ends (ray filters, tools, oil, small medicine case, extra spools, etc.—sort of an emergency case) 1 boy carrying lunch; my gun bearer, Osa's gun bearer; Boculy and Bukari; making 14 blacks in all.

Everyone knows their duty. They all withdraw to a shady spot behind me while I am making pictures, but each one on the alert should I wish any case. Each case is numbered, and I call for them by number. You see I try to be alone so as not to frighten the game, as they might see movement if so many boys were about me. Osa never comes up with the still camera unless I call her, although she always sets it up the first thing and is ready. Saunderson and the gun bearers crawl along the ground to get beside me in case of danger. I try to stand as still as I can, as animals who can't see well can sometimes make out movement.

Scenes About Lake Paradise

REPRODUCTIONS FROM PHOTOGRAPHS TAKEN BY THE MARTIN JOHNSON AFRICAN EXPEDITION[1]

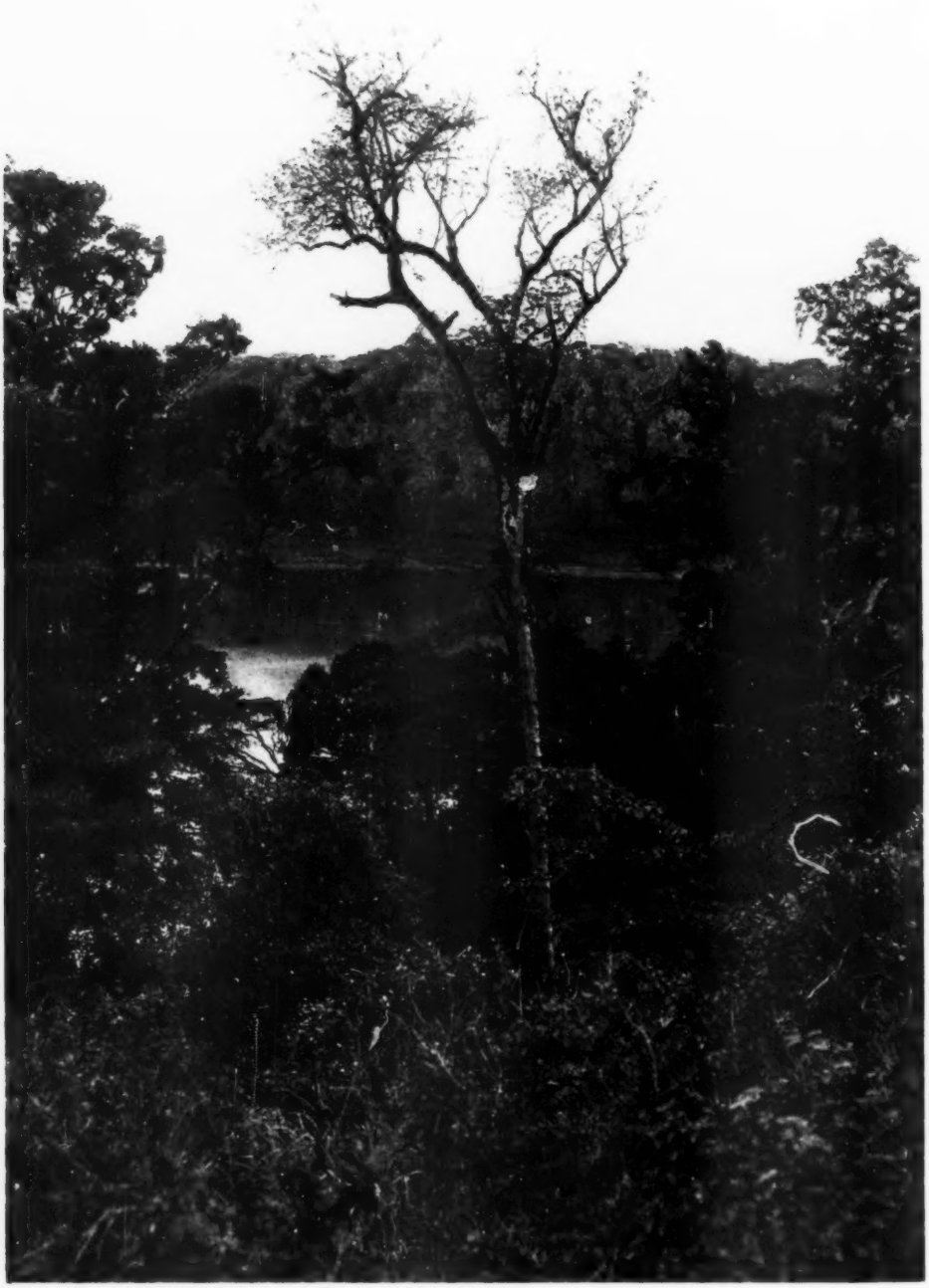
Photographs copyrighted by The American Museum of Natural History



AN AFRICAN ELEPHANT ALL-UNSUSPICIOUS OF MAN

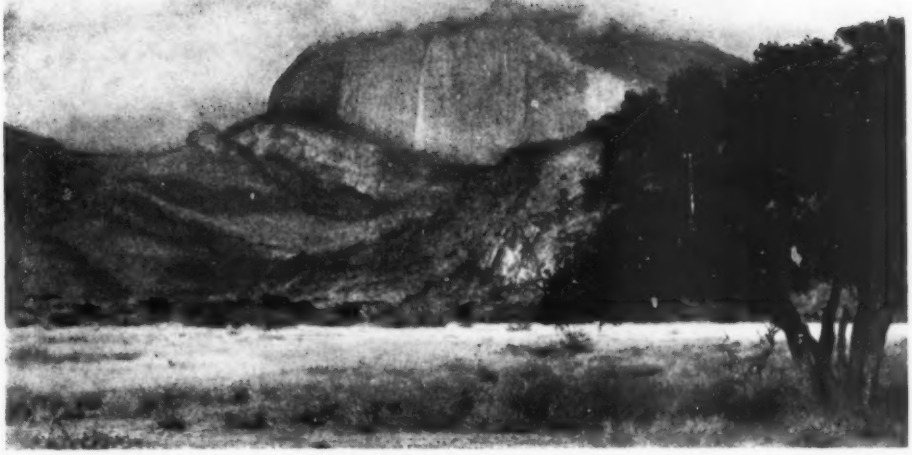
This is the elephant referred to in the "Extracts from the Diary of Martin Johnson," as "Houdini," because of its ability to disappear unexpectedly. The photograph was taken just prior to that which appears as the cover illustration of this magazine. Above we have "Houdini" with ears laid back, seemingly unaware of an audience. The cover illustration shows the great difference in Houdini's appearance when he discovers the photographer. The elephant then throws forward vast, sail-like ears

[1]Most of these photographs are being published for the first time, and have been selected by the Editor from a number forwarded from the field.



LAKE PARADISE AS SEEN FROM THE LABORATORY OF MARTIN JOHNSON

This lake seems appropriately named, and not only is attractive to man but to hosts of wild animals as well. Life of some description is almost constantly in view along its shores

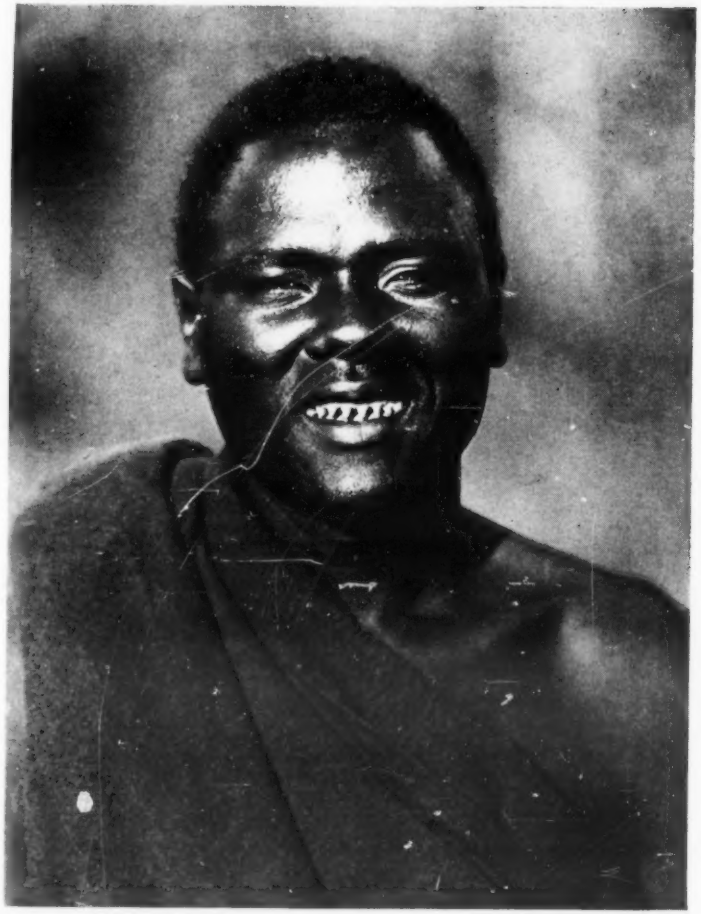


Ndoto mountain scenery has much about it reminiscent of our own western mountains. The resemblance, however, is only superficial and related to the physical features of the landscape; the flora and fauna are distinctly different

The Ngroon plains, flanked by the Ndoto mountains, lie in the Northern Game Reserve. The long grass, with scrub and small trees or thickets here and there, furnishes food for many grazing mammals

A CAMEL CARAVAN HALTED ON THE TRAIL

"A few of the camels bringing our posho from Abyssinia. The two askaris escorted them from Marsabit."—DIARY OF MARTIN JOHNSON



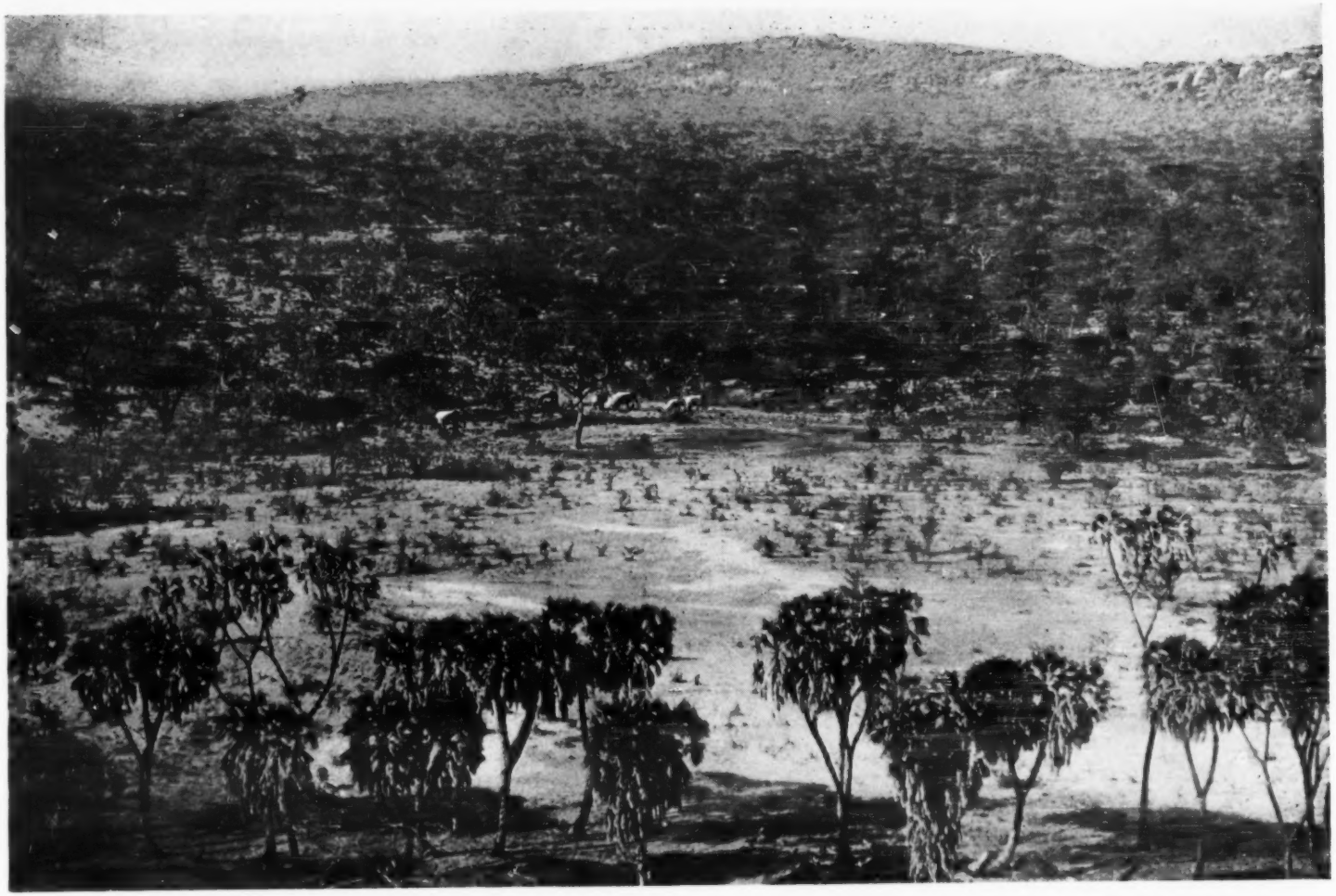
"Takatta" is one of the Wakamba porters. Natives of many tribes pass to and fro from Lake Paradise, or are employed as workers at the station. Note Takatta's filed teeth

"Fundi Kubwa" is the carpenter who cannot saw straight nor hit a nail on the head, but would be absolutely lost without the level, although with it he is unable to get anything straight

THE SECOND OR DOUBLE ROOF BEING ERECTED ON THE LABORATORY AT LAKE PARADISE

THE SECOND OR DOUBLE ROOF BEING ERECTED ON THE LABORATORY AT LAKE PARADISE

THE REAR OF MARTIN JOHNSON'S LABORATORY. THE LARGE TANK IS USED TO STORE WATER FOR WASHING THE PHOTOGRAPHIC PLATES, AND DISCHARGES INTO THE DARK-ROOM



ELEPHANTS PASSING THROUGH SCRUB FOREST "ON SAFARI." A BABY ELEPHANT OR "TOTO" MAY BE NOTED UNDER ITS MOTHER'S TRUNK, ABOUT THE CENTER OF THE HERD

MOTHER'S TRUNK, ABOUT THE CENTER OF THE HERD

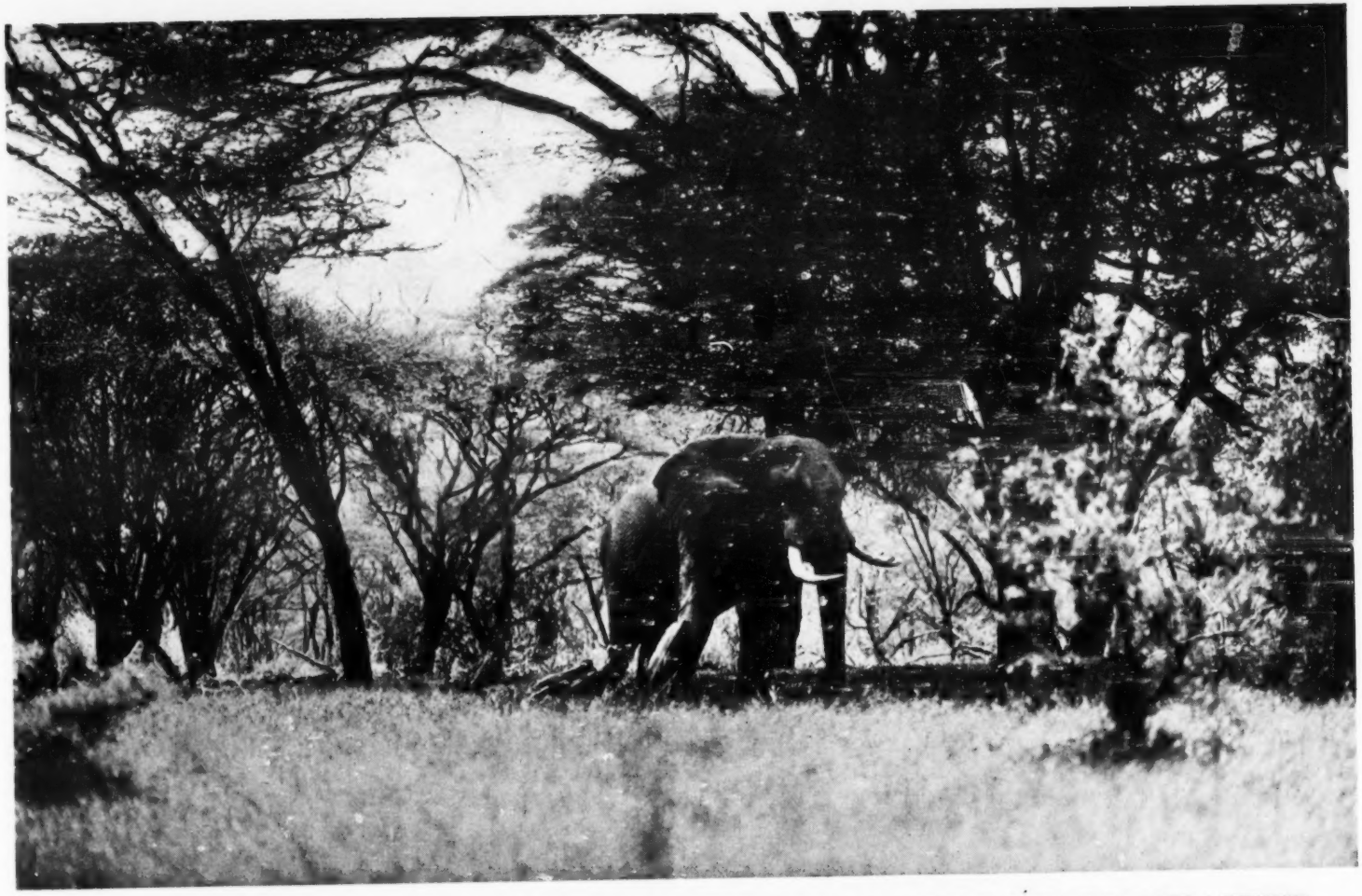
A LONE, BULL ELEPHANT, LONG-LEGGED AND LOOMING UP INTO THE SKY LINE, IS SILHOUETTED AGAINST THE WHITE CLOUDS

This elephant charged and charged again up to the rock upon which the Johnson party stood

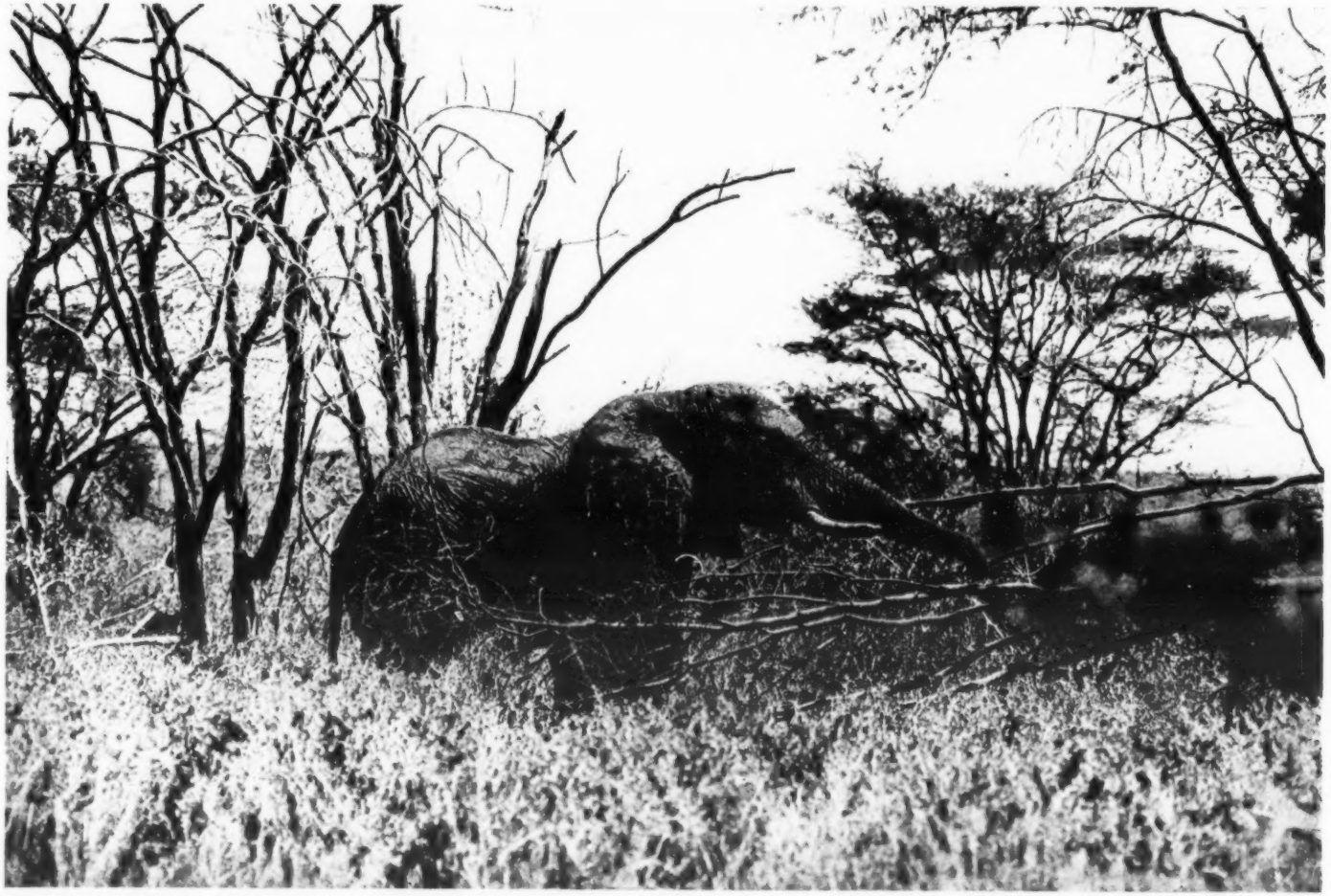
Unlike the angry elephant above, when this one became suspicious he behaved true to expectation, and ran away

A young bull elephant moving toward the camera, apparently unsuspicious, since he soon began to feed near the Johnson party

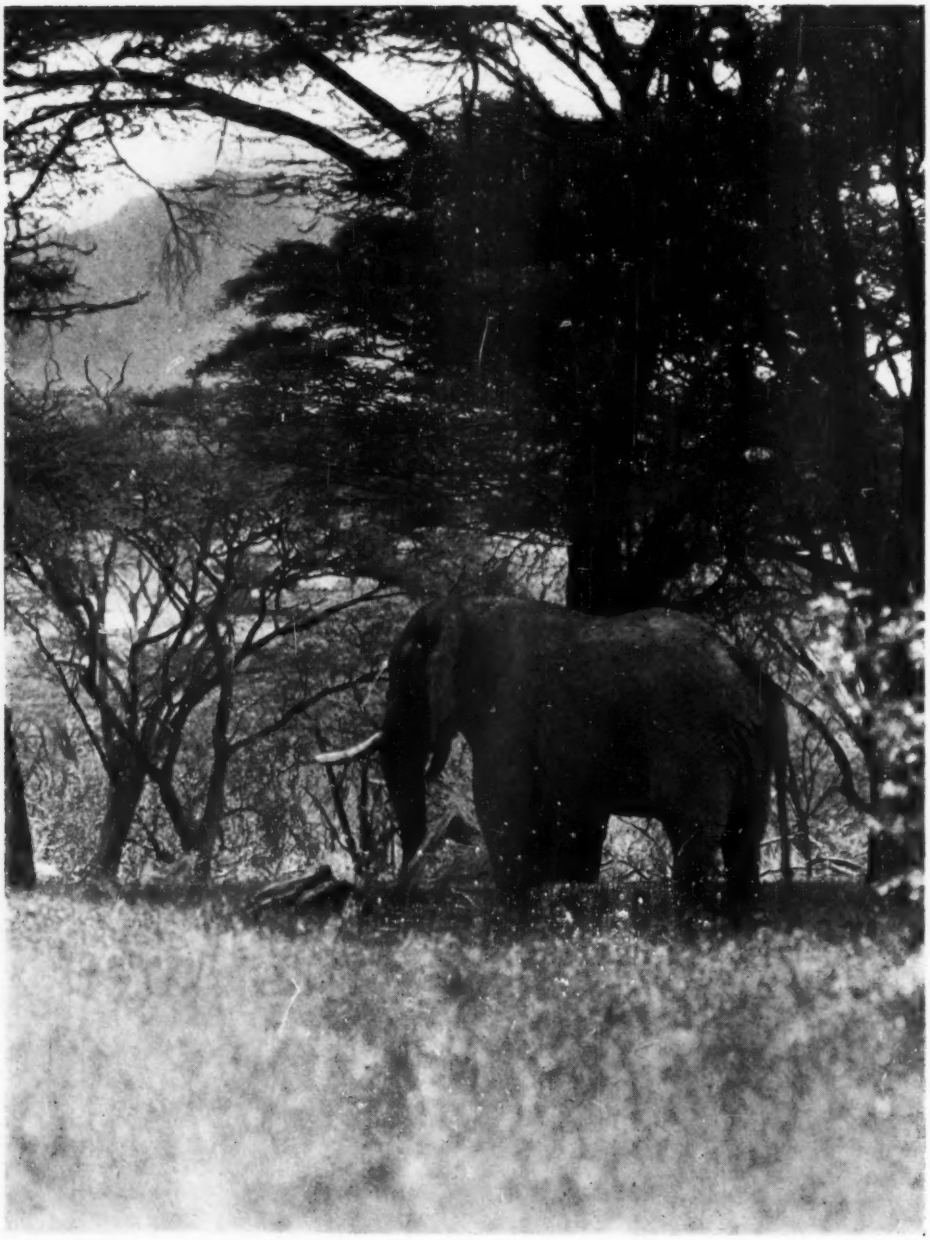
Although there are nine elephants in this group, only a few may be seen. Just after the picture was taken the elephants charged



THIS FINE TUSKER OF THE NORTHERN GAME RESERVE POSED SO OBLIGINGLY THAT MARTIN JOHNSON SECURED A NUMBER OF SPLENDID EXPOSURES



NOT AWARE THAT HE IS BEING PHOTOGRAPHED, THIS BIG BULL IS CALMLY BREAKING DOWN A SMALL TREE AND FEEDING ON THE FOLIAGE



ON THE NORTHERN GAME RESERVE

The securing of such pictures as this—fine, clear exposures of the animal in an undisturbed habitat—marks the highest development of the photographer's art. It is extremely important that series of photographs of the all too rapidly vanishing large mammals be secured while it is yet possible. Martin Johnson has the hearty support of all conservationists, and nature lovers are in full sympathy with his work. His trophies can be admired by everyone; they will endure for all time and they are obtained at no cost to the animal

BULL ELEPHANT COMING OUT OF THE BRUSH

The calm demeanor of this elephant shows that he is probably completely unaware of the presence of the photographer. As the reader will gather from "The Diary of Martin Johnson," in this magazine, the camera is set up wherever chance dictates, and the facilities for concealing man or machine may be poor or even non-existant. By anticipating the movements of the animal it may be possible to "set up" in a position to take the best photographic advantage of the light and the background; patience, the courage to remain motionless in the face of closely approaching danger, and the presence of mind to make the most of each opportunity, will do the rest

A SUSPICIOUS RHINO ABOUT TO CHARGE

The rhinoceros is an uncertain beast at best. The photographer can trust this animal only to a very limited degree under the most favorable circumstances, and when this big brute is met with in undergrowth, he becomes more dangerous than ever. After this photograph had been taken by Martin Johnson, the rhino came several steps closer, and had to be stopped. Johnson's companion, Saunderson, shot the rhino at the base of the horn. The shock was too much for the animal; it whirled and ran away. A shot on the horn does not seriously wound the rhino, but it is a powerful distractor of attention

"Lives of Game Animals"[1]

A REVIEW OF VOLUME I

By H. E. ANTHONY
Associate Curator of Mammals of the Western Hemisphere

ERNEST THOMPSON SETON is publishing a new work on North American mammals. Volume I has just appeared, Volume II is on the press and will be followed in turn by two more volumes. *Lives*, as the publishers call the book on the cover, is an edition de luxe in this its first appearance, de luxe in size and make-up, and de luxe in the exhausive treatment and characterization of the text. *Lives* is the expression of a lifetime of study and observation, or better said, of many lifetimes of observation, because the author has drawn upon the records of every one who has had a contribution to make to the subject.

No book written by Seton could be dull or uninteresting. Known to a vast audience of readers as the writer of interpretative natural history, such as *Wild Animals I Have Known*, he has been remarkably successful. But to a smaller audience he has been long known as the author of technical life-histories of mammals. His *Life Histories of Northern Mammals*, which appeared in two volumes in 1909, has been one of the most complete and authoritative mammal works of its kind ever published. But excellent as are the *Life Histories*, they are surpassed by Seton's new publication, which must remain for many years as the unquestioned leader of an almost unique class, presenting technical data in a most readable fashion.

Volume I of *Lives* is devoted to the life-histories of the cats, wolves, and foxes. Under this category are included fifteen mammals, and as the book contains 640 quarto pages there is excellent opportunity for an exhaustive treatment. The geographical range covered by the work is, roughly, the North American continent from the Rio Grande northward.

The author has endeavored to meet halfway the systematic naturalist and the taxonomist, the latter a naturalist entrusted with keeping the mammalian register or *Who's Who*, and hence one who regards a name as something sacred. Seton has gone over all of their literature and has selected enough to give the basis for a classification conforming to the best accepted practice and yet not obscuring the fundamental, outstanding facts with involved refinement of detail. For instance, he uses sketches of skulls to point out characters in classification. *Lives* would not serve, however, as a handbook for the layman to identify all of the subspecies and local geographic races. This is no great disadvantage, since on many of the ultimate determinations the authorities themselves fall out, and eventually such a situation becomes a matter of tweedledum and tweedledee.

Seton has had unrivaled opportunities for first-hand observations of mammals, but this has not satisfied him. He has read everything published by other men on the subject of mammals and has kept a file of records and references that is seemingly all-

[1] *Lives of Game Animals*. Vol. I. By Ernest Thompson Seton. Doubleday, Page and Company, 1925.

inclusive. One of the most valuable features of *Lives* is the bringing together from hundreds of scattered sources of everything worth while on the point in question. The authors quoted include every one of the recognized authorities. In addition Seton reaches out to take in travelers' accounts, hunters' tales, and trappers' yarns. It requires a nice judgment to sift from such sources —from orthodox authority to ridiculous yarns—all of the intimate details of a mammal's life-history, because of the great gaps in the picture; and sometimes the hunter's tale may not be entirely fiction, or again a fact may have been passed down along authoritative channels until it is, to say the least, far from the original source, and probably was subject to revision in the first place. Seton's preface to his second volume of *Lives* (see page 583, of this magazine) indicates this sifting process.

Seton undoubtedly will be criticized because he has included in his descriptions of mammal behavior many stories and accounts only partly or not at all verified by scientific observers. These stories might be roughly grouped in two categories, those that are probably true and more or less supported by observers of unimpeachable standing, and those that are interesting if true, but quite likely not true in their entirety. The first group of stories can do no harm because they are fitted in with the testimony of others and the reader will not be led astray. The more dangerous, second type of story, is so handled that it will be misleading to very few readers. Seton introduces these accounts by calling attention to their unusual nature and by cautioning the reader that they may be unworthy of full belief, or should be considered only as very remotely possible. But before the treatment of any mammal is completed, the author sets forth all of the facts and near-facts; he vouches personally for none of the latter but places them before the reader only in the attempt to make the picture as vivid as possible; the reader is to interpret the evidence for himself or, to come back to the simile of the picture, he has at his disposal highlights which he may place on the canvas if he believes that the subject can stand them.

Personally, I like to read the "stories" about the mammals, and I believe that, in the main, a good selection has been made. I feel that any criticism of the "stories" will lose most of its force when it is noted that the names of all our best American naturalists appear constantly throughout the text and when one realizes the responsibility they have assumed for the greater part of the life-histories. The "stories" are offered as suggestions and to cause observers to be on the lookout for confirmation.

Seton has developed his subject with a wealth of detail that overlooks no fact, however trivial. In the extracts from Volume II of the *Lives*, following this review, it will be seen how the author has planned his work and how indefatigable he has been in executing it. As an example of the fullness of description devoted to each mammal the first few pages of the life of the skunk are quoted. All of the common names are listed, the scientific name or names are cited, and a long column of various Indian names follows. Nowhere have the vernacular names of mammals been set forth as completely as in this work of Seton's, and if one is to popularize natural history it must be admitted that this is a feature of prime importance. The reader the-

comes to an exact and detailed description of the mammal, and since this is taken directly from specimens themselves, it may be relied upon explicitly. Seton has avoided the more restricted point of view of the taxonomist or maker of species and subspecies, and treated his creatures as individuals of more comprehensive identities. This is the only possible method of approach for a work intended for the general public and, after all, the life-history and behavior of the mammal is about the same whether it be subspecies "a" or "b" or "y" or "z," but if it should differ in detail and the fact has been recorded, you will find that Seton has mentioned it in his *Lives*.

In describing the life of the cougar, a typical example from Volume I, Seton employs no less than thirty-nine major headings, with one hundred pages of text. The known geographical range of the cougar is given on a full-page map, and the host of topics under which the data is set before the reader includes such items as Primitive Numbers; Haunts; The Voice of the Cougar; Powers; Speed; Spring; When the King-Cat Goes A-Hunting; The Chase of the Cougar, etc. etc. Two hundred and twenty-four footnotes direct the reader to authors and original sources, and indicate the extensive background upon which the text is based. At the close of the account a comprehensive bibliography is given, should the reader desire to pursue his study of the cougar yet further.

The author has been very fair in giving full credit to any writer whose work he has quoted. Solely on its merits as a source-book, Volume I must be rated very high. The "lives" are written to instruct, they have a serious purpose, and yet in spite of this handicap they are so readable that they form a time-consuming reference book on mammals. I mean by this that when one turns to the book to check up some point of mammal behavior, he encounters such interesting reading that he lingers far beyond the point where his question has been answered.

Seton has had the benefit of a large board of special advisors. He has sent manuscripts for a critical reading to many of the leading mammalogists, and the list of names given on the page of acknowledgments shows to what extent his work is sponsored by those who have made mammal study their life work. No other work on American mammals can show so strong a backing for the author.

The accounts of the various mammals are well illustrated by photographs and by Seton's own sketches and drawings. The photographs are excellent, and while many have been taken by the author himself, a complete list of the photographers whose work appears includes many well-known nature photographers. But the most useful, and in some ways the best of the mammal portraits, are from the pencil and brush of Seton, who has long had the reputation of being one of our foremost mammal artists.

Seton chooses his poses carefully and all his mammals have character and the fidelity to life that is essential to successful mammal portrayal. The artist is so fully in sympathy with his subject that he has been able to catch with pen and pencil subtle expressions and postures which it would be impossible ever to photograph. There is a humerous, whimsical touch in Seton's pen-and-ink headpieces and tailpieces which makes them a truly delightful feature of the book. They are crammed with the salient facts of the mammal's career and may epitomize the whole

life-history, for all that they are meant in fun.

There are also a host of detail sketches which answer questions very frequently asked and too seldom answered by books on mammals. The tracks of the mammal are figured, and the shape of its paws, or any other particular structures that require special emphasis. Artists seeking to sketch mammals will find *Lives* an invaluable reference book because of the many figures which show the position of the limbs, manner of holding the head, carrying the tail, and so on.

Because Seton has always had such a great interest in wild life and championed every mammal that was threatened with popular disfavor, a strong plea for conservation runs all through *Lives*. He would have no mammal exterminated, and for the most predatory species, those whose destruction is demanded because of economic pressure, he makes out a good case on sentimental grounds. Where the odds are so heavily against the predatory species, it is comforting to the cause of conservation to meet an author with the convictions of Seton and to enjoy his facility of expression.

While this review has thus far conveyed the impression that no fault could be found with *Lives*, the publication is no exception to the rule that the work of man cannot be absolutely perfect. It is true, nevertheless, that the faults are, for the most part, obscure, and the good features are so predominantly conspicuous that it seems captious to utter destructive criticism.

Occasionally the photographs show signs of retouching but, while the print may have needed such hand-work and no part of the scientific value would be lost thereby, the retouching has been poorly done.

Because of its large size *Lives* will be open to the criticism that will always greet a de luxe edition; the volume is too large to be handled comfortably if one wishes to use it away from the library table. It is greatly to be hoped that such a useful work will be brought out in an edition of smaller size.

To sum up, Ernest Thompson Seton has produced a book so predominantly superior as to be beyond comparison with any other work of like scope. To the non-scientific reader it offers authentic, authoritative data which goes just far enough into the technical to meet average needs and yet stops short of overwhelming detail and subtle distinctions; to the dyed-in-the-wool mammalogist, *Lives* presents a veritable encyclopedia and compendium of facts, —facts frequently asked for and facts difficult to ascertain, only to be gathered by long and tireless search in literature. As a source-book it provides in well arranged form a quick contact with hundreds of references and workers. For all readers of whatever station Volume I of *Lives* will prove interesting and instructive, fascinating, and thought-provoking, a book to consult and enjoy frequently, and a possession to be prized and desired.

The following pages will afford a better idea of the general plan of *Lives* than I can give in a review, but they, too, are inadequate to bring out the full scope of Mr. Seton's epic production, which must be seen to be fully appreciated.

"Lives of Game Animals"

By ERNEST THOMPSON SETON

THROUGH the courtesy of Doubleday, Page and Company, NATURAL HISTORY has been able to secure from Mr. Seton the following excerpts from the second volume of *Lives of Game Animals*, now on the press. The manuscript and pictures were selected to illustrate some of the many good features of this monumental work on North American mammals, and the arrangement of text, et cetera, is as nearly as possible that of the published book. There is, however, no continuity of thought in the order of presentation. These excerpts may be considered, therefore, as sample pages of Volume II and serve to demonstrate the points brought out in the review of Volume I, pages 579–82 of this magazine.—THE EDITOR.

PREFACE

VOLUME II is done. It has been delayed through the abundance of material, the superabundance of ideas, new and sometimes incredible, that continued to arrive and demand consideration. Some have been included that are not in the line of modern thought; that is, of the established order. As light on their significance, I offer two incidents,—a history and a fable.

In England, about 1770, smallpox of a deadly type was rife. A dairymaid, allured by the high wages, offered to nurse those stricken with the disease. When warned that she was risking her life, she replied: "I cannot take that disease; I have had cowpox." This old wives' tale amused the doctors, and they dismissed it with a laugh. But one of the younger men said: "Let us investigate before condemning." He did so, and thus laid the foundation of the whole modern school of prophylactic medicine. His name was Edward Jenner.

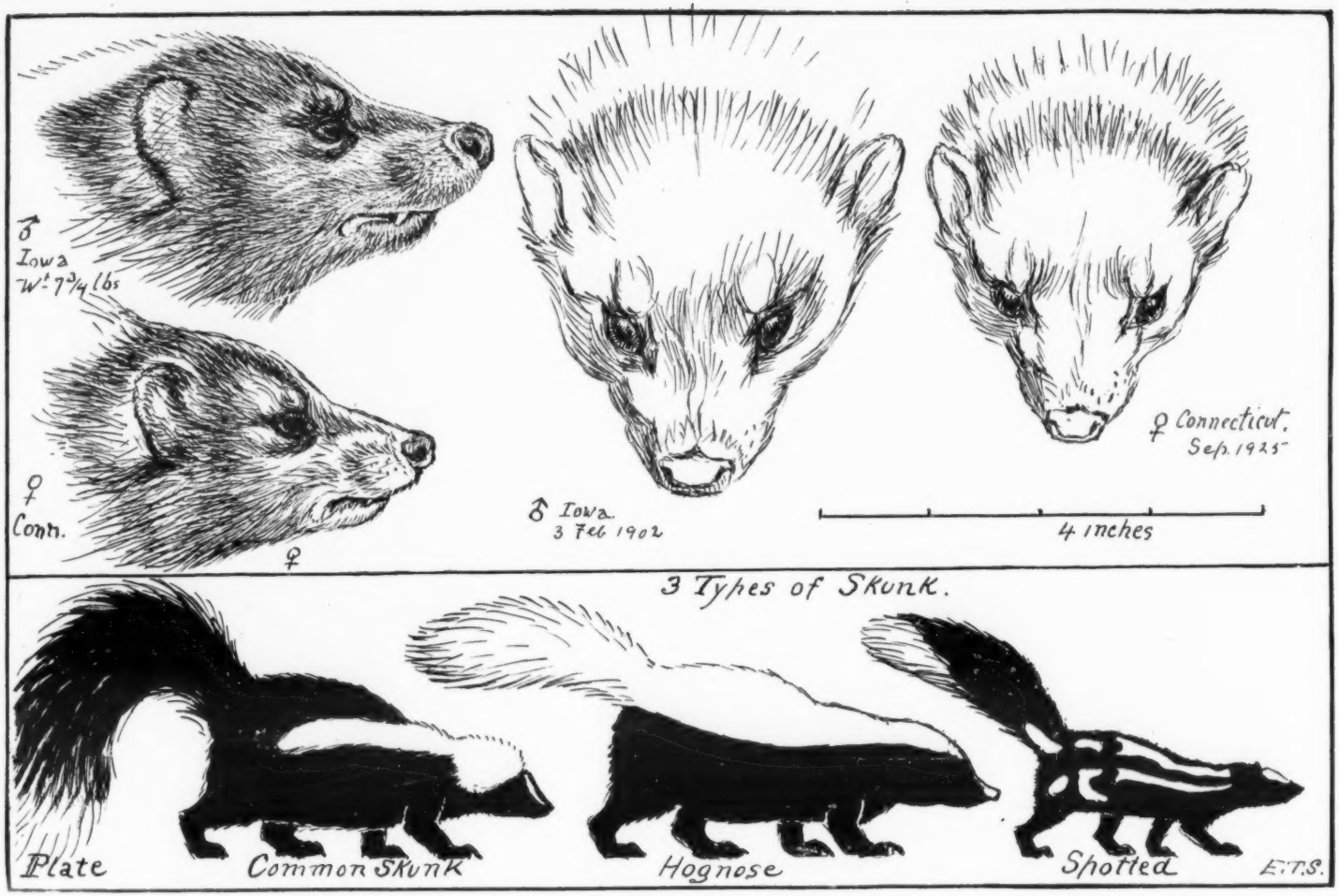
A venerable old man with a pen behind his ear, ink on his fingers, and a bag on his back, went up the main street of Humantown, calling out as he went:

"Lies! Any old lies today? Biscuits for lies today!"

He had a basket of sweet wafers, or biscuits, on one arm, and they were shaped like a human ear. These he was exchanging for the lies, that were very abundant in this town.

Most of the inhabitants freely gave them to the man; some even pressed them on him: but a few had to be repaid with at least a wafer. Very soon, the old man's bag was full.

It was a new thing to collect lies, and many jokes were bandied about at the expense of the old man and his odd occupation.


♂
Iowa
Wt. 7¾ lbs
♀
Conn.
♀
♂ Iowa
3 Feb 1902
♀ Connecticut.
Sep. 1925
4 inches
3 Types of Skunk.
Plate
Common Skunk
Hognose
Spotted
E.T.S.

The strange merchant left the main street, and a little child had the curiosity to follow him. The venerable one turned aside through a door into a beautiful garden in the very heart of the town, and yet quite unknown. He closed the door, but the child peeped through the keyhole, and saw the old man take the bag of lies and give it a good shake. There was a commotion and a seething inside for a time, and the mass seemed to be smaller.

"Ah, hear them eating each other up!" chuckled the old man.

Another shake was followed by more commotion and another shrinkage. The collector's face beamed.

A few more shakes, and the bag seemed actually empty; but the old man opened it carefully, and there in the far corner, was a pinch of pure gold.

The child reported all these things, and the next time they saw the old man, the people demanded who he was. He answered:

"I am the historian."

LIFE XXVI—THE SKUNK

Common Skunk, Big Skunk, Alaska Sable, Black Sable, Striped Skunk, Smell-cat, Two-striped Skunk, Sachet Kitten, Mephitic Weasel, American Polecat, Big Polecat, Wood Pussy.

Mephitis mephitis (Schreber)

(L. *mephitis*, a pestilential exhalation.)

Viverra mephitis Schreber, 1776, Säugthiere, pl. 121.
Mephitis mephitis Allen, 1902, Science,n.s., Vol. 16, p. 115, July 18.

TYPE LOCALITY—Eastern Canada, i.e., Quebec.

FRENCH CANADIAN, *l'Enfant du diable; le Chinche; la Mouffette; la Bête puante.*
CREE, OJIB. AND SAUT., *Shee-gawk'.* In this, we see the origin of the word "Chicago," meaning "Skunk-land."
YANKTON, SIOUX, *Mah-cah.*
OGALLALA SIOUX, *Mah-kah'.*
CHIPEWYAN, *Nool'-tsee-a.*
HURON, *Scangaresse* (Sagard-Théodat)
ABENAKI, *Seganku* (Rasles). The word "Skunk" is traced to the last two Indian words.
MEXICAN, *Zorilla.*

THE true Skunks belong to the Weasel Family Mustelidæ and to the subfamily Mephitinæ which is divided into three principal groups:

Big Skunks, genus *Mephitis* Geoffroy and Cuvier.
Spotted Skunks, *Spilogale* Gray.
Hog-nosed Skunks, *Conepatus* Gray.

The genus *Mephitis* (Geoffroy and Cuvier, 1795), are about the size of a common House-cat; have short ears, long fur, very large and bushy tails, are black in color, with a thin white stripe on the face and a broad one beginning on the nape, forking on the shoulders to reach to the hindquarters, or sometimes nearly to the tip of the tail; they are at least partly plantigrade, and have the foreclaws very

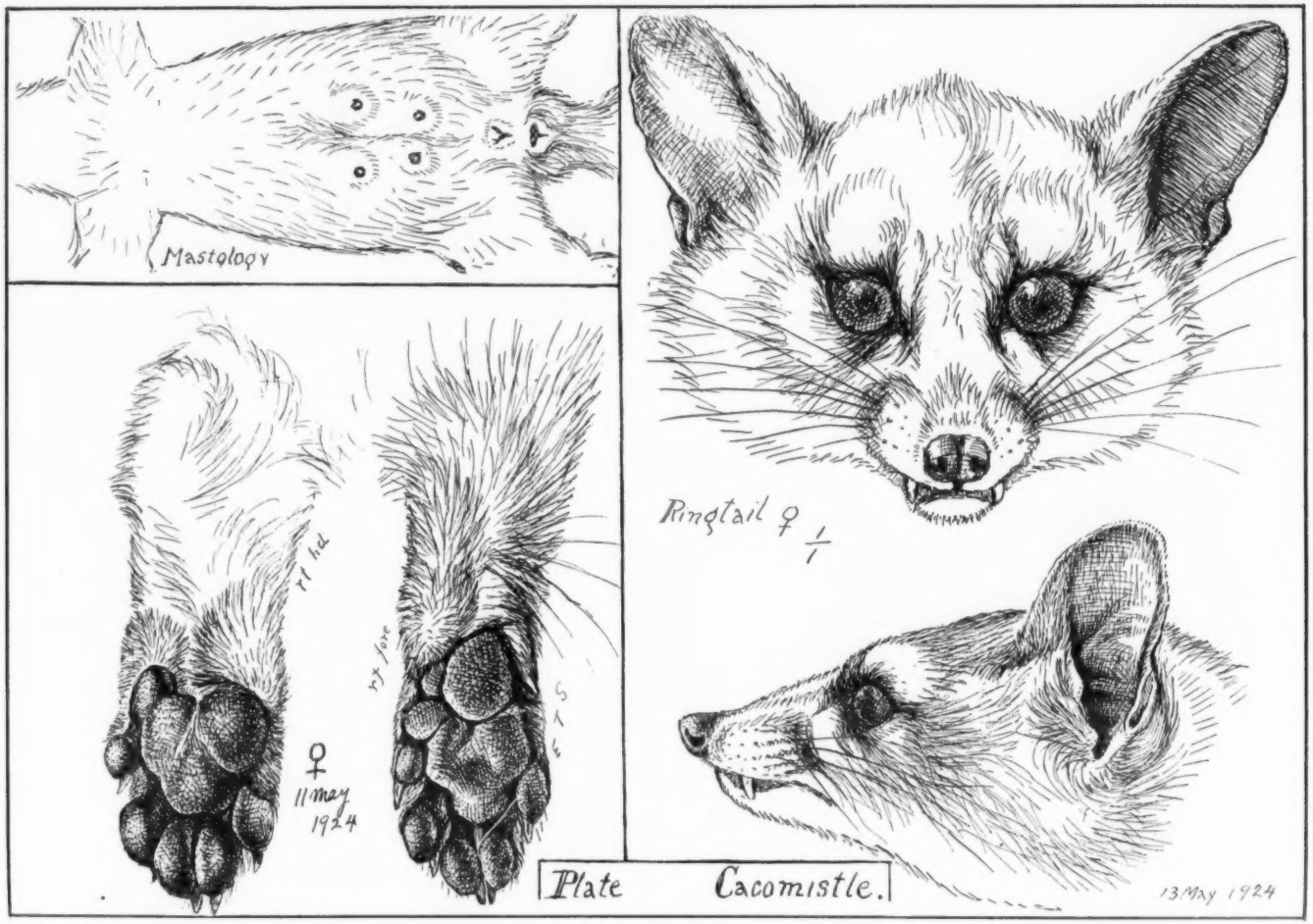


Plate Cacomistle.

large and suited for digging; but above all, they have greatly developed anal glands which produce the liquid musk that they eject with such notable effect in self-defense.

The teeth are:

Inc. $\frac{3}{3}-\frac{3}{3}$; Can. $\frac{1}{1}-\frac{1}{1}$; prem. $\frac{3}{3}-\frac{3}{3}$; mol. $\frac{1}{2}-\frac{1}{2}=34$

In addition to these generic characters, the Skunk has:

Size. Length, about 28 inches (711 mm.); tail, 10½ inches (267 mm.); hindfoot, 3¼ inches (82 mm.).

Weight. A full-grown male Skunk in my menagerie, April 25, 1925, weighed 5½ pounds, a yearling 3½ pounds, 7 females (*nigra*) respectively 4, 4, 4, 4, 4¼, 4½, and 6 pounds. The last two were two-year-olds, the first five were yearlings. I have had several breeding females that weighed only 3 pounds.

A large male which I weighed in the Yellowstone Park, July 29, 1897, was 8½ pounds; another, a winter specimen, taken in Iowa, weighed 7¾ pounds. In my menagerie, I have had several males that tipped the scales at 10 pounds. These were of the large Northern race *hudsonica*, and came from Winnipeg.

On October 2, 1883, while traveling on the prairies near Rapid City, Man., I shot an enormous Skunk who commanded me to "stop and go around." Alas, I had no means of accurately weighing him, but I was a strong young man at the time, and I know my hand holding his hind leg (he was too long to lift by the tail), was tired out before I got him to the wagon two hundred yards away. I set his weight at 30 pounds. An old settler with me, a man accustomed to "hefting Hogs," said: "No, he don't weigh much over 20 pounds." These, of course, were "hunters' guesses," but I feel sure now that this old warrior was well over 15 pounds in weight; especially as I note Allan Brooks says of the British Columbia Skunk (*spissigrada*), during the salmon run: "They then get very fat, the ordinary weight of an adult then being 10 to 16 pounds." (*Recreation*, June, 1900, p. 434).

At birth, they weigh about half an ounce, and at eight weeks, 1½ pounds.

Color. General color black, with a thin stripe down the face between the eyes, and the usual white patch on the nape from which a broad white, or creamy white, stripe goes back to the shoulders, where it forks and continues along the sides into the tail, which is of black hairs with white bases, and ends usually in a white tuft or pencil. There are endless individual variations, especially in the length of the back stripes.

Their *black and white color*, with their size, their slow movements, and their *immense bushy tail*, usually held aloft, will distinguish the true Skunks from any other animals found in North America.

Brown or cream-colored freaks of most kinds of Skunks have been found.

LIFE XXV—THE RINGTAIL

NELSON sums up its food habits thus: "Like its relative, the Raccoon, the Cacomistle, with a taste for a varied fare, takes whatever edibles come its way. It stalks Wood-rats, Mice, and even Bats in their rocky haunts, and birds in bushes and low trees. About the southern end of the Mexican table-land, it is much disliked for its robberies of

chicken roosts, especially when these are located in trees. Insects of many kinds, larvæ, and centipedes are eaten, as well as a great variety of fruits, including that of the pear-leaved cactus, and dates, figs, and green corn." (W. A. N. A., p. 587). In amplification of the last, he says:—"Ring-tailed Cats regularly locate among rocky ledges, neighboring orchards, or other cultivated areas where they may gather some of the bounty provided by man. I found them more plentiful among the broken larva cliffs bordering date-palm orchards in Lower California than in any other place. When the dates were ripening, they prowled about under the palms after dark, with gray Foxes and Spotted Skunks, to pick up the fallen fruit." (W. A. N. A., p. 587).

The captives in my menagerie would eat any sort of meat or sweets. Dates and figs were especially acceptable. Sugar in any form, they would devour with avidity.

His Way of Life

What should it be for a creature that is a cross between a Coon and a Fox, with the fur of a Flying Squirrel? Dull and lethargic he may be during the heavy hours of sun heat, that all wise creatures give to sleep; but when the twilight has given place to the gloaming, and the gloaming to black dark, this bright-eyed, playful, nimble child of the high-holes, peers forth from his safe retreat, swings slowly at first like a Coon; then limbering up, he begins to leap and scramble like a Squirrel. His great ringed tail is swinging squirrel-fashion, as he courses up long, sloping limbs, or makes a flying leap across a five or six-foot space; and one wonders if it does not answer as a parachute in case of a fall.

At the slightest promising sound of bird on roost or in nest, or of catchable young Rabbits in the undergrowth, he freezes. Still as dead he holds, but every line and fiber of his make-up is tense with life and pent-up energy. The beautiful animalism of his whole body finds fit expression in his face. All who have marked those big liquid eyes, the mobile snout, the alert expression of the visage, are enthusiastic over its beauty and look of bright intelligence. Even the ears, so little moved in some creatures, are full of expression in the Ringtail; while the long, black, abundant whiskers do their part as vibrant feelers, and as features that show something of the little mind within.

His nightly prowl must be sometimes through the tree tops also, for he gathers the "high simmons" where they hang. But he is also much on the ground, for there are found many of his favorite foods; and there next morning, we find his endless chains of trail.

Though so nocturnal, the Ringtail has a sunlight habit that all the woodwise indulge in from time to time as a tonic,—that is the periodic sun bath.

"Sometimes," says Audubon, "the Ring-tailed Bassaris may be seen squatted on the top of a branch, basking in the sun, and half rolled up, appearing almost asleep. On the slightest manifestation of danger, however, he darts into his hole (which is always within a foot or two of his basking place), and he is seen no more." (Q. N. A., II, p. 317).

A final paragraph by Audubon gives an entirely new chapter of the Ringtail's life, emphasizing as it does, the Squirrel side of its nature, and showing that it must be much less strictly nocturnal than the previous observations might lead one to suppose.

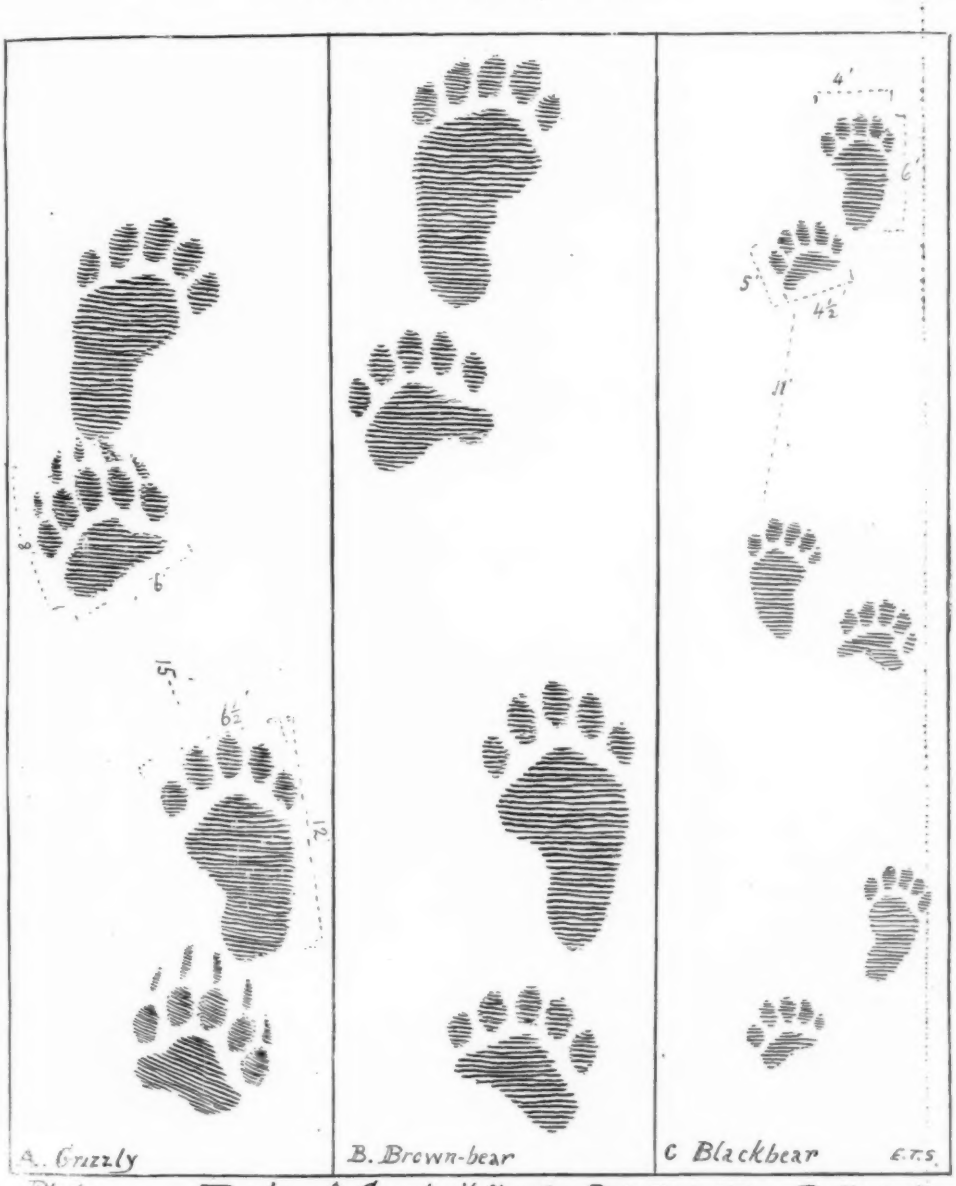


Plate Tracks. A Grizzly. Yellowstone Park, Sep. 7. 1912. B. Kadiak Brown-bear. Washington Zoo. C. Blackbear. Athabaska River, Sep. 30. 1907. The chief differences are in size; also the Grizzly often shows claws.

LIFE XVI—THE GRIZZLY

NEVER ATTACKS MAN

Notwithstanding the sinister reputation that has won for him the names *horribilis, grisly, ferox*, etc., the Grizzly, according to all the best authorities, never attacks man, except when provoked. That is, he is a harmless, peaceful giant, perfectly satisfied to let you alone if you let him alone.

Even in the palmy days of the West, when he was the unquestioned monarch of the range, trapper and cowboy

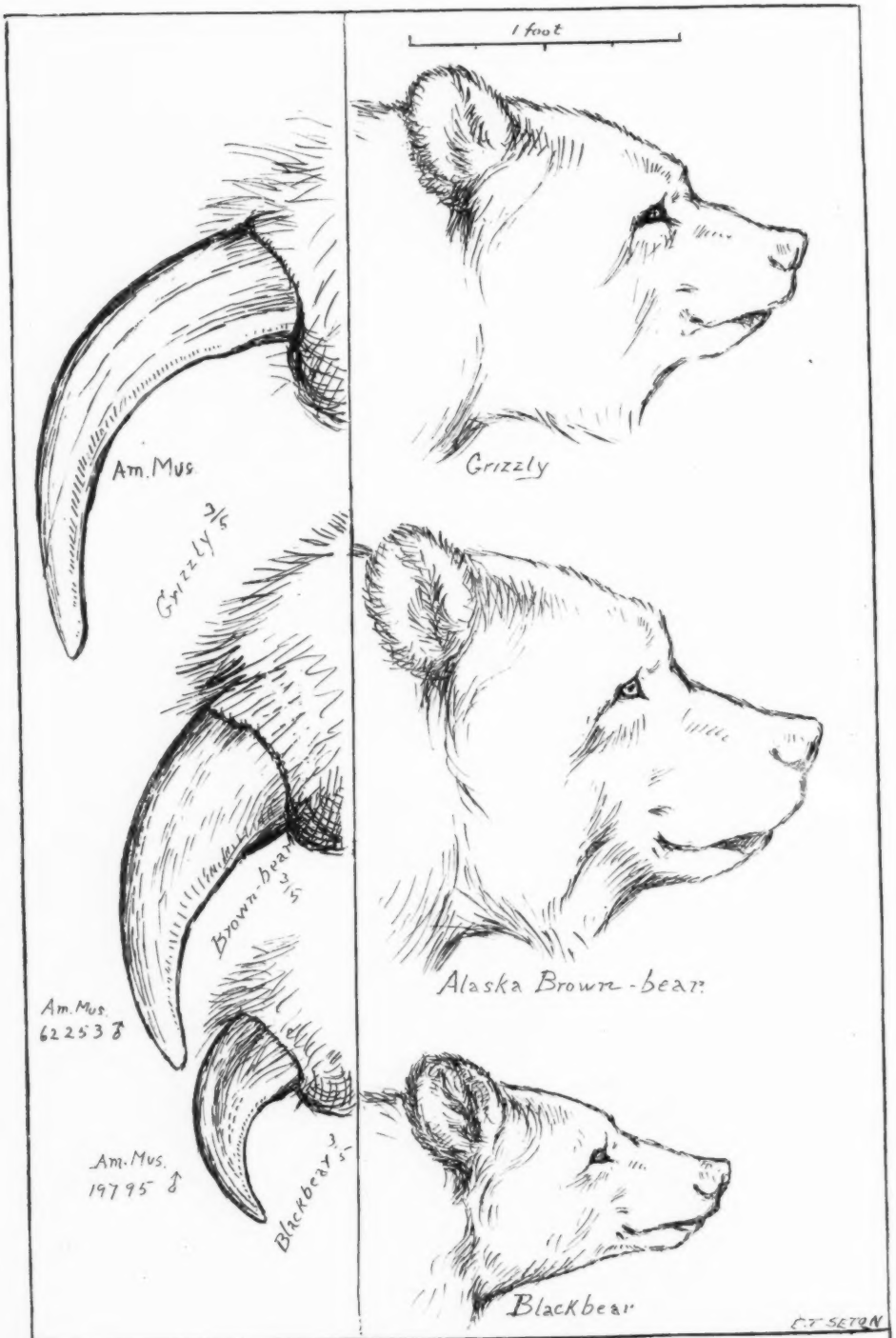


Plate — Claws and Profiles of Bears.

knew right well that they need only exercise a little self-restraint, show some decent courtesy to this big dignified giant in the fur cloak, and they need not fear but that he would respond.

In their first recorded meeting with the Grizzly, Lewis and Clark say: "Those we had seen did not appear desirous of encountering us." (April 29, 1805). In the course of their journey, they had about a dozen encounters with Grizzly Bears. In each of these, with the possible exception of two, the Bears were peacefully disposed until attacked. The two cases are discussed later.

In 1820 Major Stephen H. Long wrote: "Notwithstanding the formidable character of this Bear, we have not made use of any precautions against their attacks, and although they have been several times prowling about us in the night, they have not evinced any disposition to attack us at this season." (Exped. Rocky Mts., 1823, II, p. 57).

In the early 40's Rufus B. Sage, the Rocky Mountain hunter, wrote of the Grizzly that he knew so well: "He will almost invariably flee at the sight or scent of man, and seldom attacks anyone unless wounded. When shot, he generally runs at full speed towards the sound, and woe to the unfortunate hunter who then comes in his way, unless fully prepared for a deadly encounter." (*Rocky Mt. Life*, 1857, p. 156).

About the same period, there was in California an old-timer named Walter Colton. He was a man of power, and for three years was Alcalde of Monterey. He left a journal of his term in office under the title *Three Years in California*. His opportunities of seeing game were unlimited, and under the heading of "Friday, December 11, 1846," is the following:

"The Grizzly Bear is the most formidable and ferocious animal in California; and yet, with all this ferocity of dispositoin, rarely attacks a man unless surprised or molested. The fellow never lies in wait for his victim. If the hunter invades his retreat or disputes his path, he will fight, but otherwise contents himself with the immunity which he finds in the wildness of his home and the savage grandeur of his nature."

Sir John Richardson says of his assistant, Thomas Drummond, who was the botanist on the Second Franklin Expedition, and made an important side trip to the headwaters of the Athabaska:

"Drummond, in his excursions over the Rocky Mountains, had frequent opportunities of observing the manners of the Grisly Bears, and it often happened that in turning the point of a rock or sharp angle of a valley, he came suddenly upon one or more of them. On such occasions, they reared on their hind legs and made a loud noise like a person breathing quick, but much harsher.

"He kept his ground without attempting to molest them, and they on their part, after attentively regarding him for some time, generally wheeled round and galloped off, though, from their known disposition, there is little doubt but he would have been torn in pieces had he lost his presence of mind and attempted to fly. When he discovered them from a distance, he generally frightened them away by beating on a large tin box, in which he carried his specimens of plants. He never saw more than four together, and two of these he supposes to have been cubs; he more often met them singly or in pairs. He was only once attacked, and then by a female, for

the purpose of allowing her cubs time to escape. His gun on this occasion missed fire, but he kept her at bay with the stock of it, until some gentleman of the Hudson's Bay Company, with whom he was travelling at the time, came up and drove her off." (F. B. A., I, pp. 27-28).

W. H. Wright, of Grizzly fame, writes: "Twenty-five years of intercourse with these beasts has taught me to regard them with the most profound respect. . . . .

"I have never found him the ferocious, ill-natured brute that he has the reputation of being." (Grizzly Bear, p. 233).

On another page he tells of his hunting partner, Jack D. O'Brien, finding himself being watched by a Grizzly with three yearling cubs. His Dog barked at them, thereby provoking a fight. The mother Bear charged and fought till she and the family were killed.

"This is the only instance," he says, "that I have ever known personally where a Grizzly attacked a man without provocation, and in this case I lay it to the Dog. The Bear was an old one with three yearling cubs, and the presence and barking of the Dog were naturally offensive to her. And as the cubs and the Dog were doubtless the reasons for her unprovoked attack upon the man, so also the cubs and the Dog proved his salvation. For the Bear left him again and again and returned to interpose herself between the barking Dog and her cubs, which had not crossed the creek." (Grizzly Bear, p. 93).

An Unusually Fine Example of Beaver Industry[1]

By IRA A. WILLIAMS
Consulting Geologist, Portland, Oregon

I HAVE long harbored the desire to see a beaver at work. The industry of this little animal, though well known and frequently commented on, is so out of the ordinary that such an ambition may not seem widely out of place even in one whose professional interests lie in a quite separate field of science.

Evidence of the presence of beavers in the Pacific Northwest, while no longer widespread, is nevertheless still plentiful in many places. Along many of the streams that flow westward from the Cascade Range of mountains in Oregon, beaver cuttings and their trails are rather common features. Their ponds, dams, and houses are less frequently seen.

While on a geologic reconnaissance in the upper reaches of the Clackamas River in the summer of 1924, some thirty miles southwest of Mount Hood, it was the almost ever present evidence of beaver that once more aroused, and to an unprecedented pitch, the smoldering longing to observe one, or a colony of these animals if luck should so prevail, at their daily tasks. That fortune should swing my way to that extent was scarcely to be contemplated, neither was the time available to seek out their haunts leisurely as would be the method of the accomplished naturalist. But it was mine to take things as they came, and though I failed to realize the ultimate height of my yearning, the accompanying photographs will perhaps testify to the nearness to which the coveted goal was approached.

Our pack train left us on a late July day just above the union of the Oak Grove fork with the main Clackamas River, for the investigation of a stretch of morainal country.

It was during the course of our meanderings among indiscriminately spaced knobs of basalt, across glacial ridges and interspersed meadows or boggy flats, that we, Fred, Lloyd, and I, first came upon this most interesting example of beaver activity. It appeared at first sight but an open space within the forest, surrounded by a wide fringe of thickly set but lifeless firs and alders, many of the former from forty to fifty feet or more in height. Scarcely a second glance was necessary to note, however, that to the limit of this border every one of the dead trees stood with its roots submerged in water. Within this fringe, water was seen to cover an open area several acres in extent.

So obviously peculiar was this state of affairs that it could not but attract the attention of even one bent on the study of as practical a problem as the essentials of a water-power site. Here, to all appearances, a storage project had been brought into being very recently. For it so happened that Fred had, in summers past, many times pastured his saddle- and pack-horses in this very same forest opening, where what was now water had hitherto been a flower-besprinkled meadow of good grazing ground, lengthwise of which a small stream meandered its way.

Our first thought was naturally of the beaver, and we came at once to a

[1]Photographs by the author.

FROM EAST END OF DAM

FROM EAST END OF DAM

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LAKE, AND DAM FROM WEST END

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MAIN DAM AND ONE AUXILIARY DAM FROM BELOW

MAIN DAM AND ONE AUXILIARY DAM FROM BELOW

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THE ARCHITECTURAL JUDGMENT OF THE BEAVER CANNOT BUT BE ADMIRED

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THE BEAVER HOUSE STOOD FORTY FEET OUT IN THE LAKE. TOWARD THE SHORE THE WATER WAS ABOUT EIGHTEEN INCHES DEEP BUT TOWARD THE CENTER OF THE LAKE IT WAS FOUR AND A HALF FEET DEEP

dam, thrown across a narrow break in the basin's rim through which the outlet had formerly flowed. No one having followed the progress of the dam's construction, it is of course not possible to say how rapidly it was built. Its appearance of newness and the evidently recent fateful rise of the water among the firs, made one feel that its beginning could not have been longer at the most than a couple of seasons prior to our visit.

That the members of this beaver community must still be there went without saying. Neither the manner of our coming, however, nor the lateness of the day, favored our catching a glimpse of any of them, even if they were at home. So with but a hurried casual inspection we passed along, away from this nucleus of beaver land, with the resolve to come again soon, when our movements might be so planned beforehand that the beaver, wary animal though he is, would be quite unwarned of our approach.

It was the afternoon of July 26 that we managed to come this way again. Cautious as we were, and with cameras prepared for whatsoever opportunity might arise, no sign of a ripple broke the quiet of the beaver pond. We were compelled this time, as before, to be satisfied with what could be seen of the works of this genius of the forest world.

So we trained our films first upon the main dam along whose crest we had walked a few days before. The structure is beautifully curved upstream, its top five and one half to six feet above the shallow water at its lower side. Its full length around the curve, abutment to abutment, is a little short of one hundred feet. The waters of the new-made lake stood four and one half feet deep against its upper side.

The architectural judgment of the beaver in design, if not his particular engineering skill in construction, cannot but be admired. Here were three dams across the same small outlet stream, the major structure against whose upstream face pressed the impounded water of the open pond, and below it two auxiliary dams both incomparably smaller in all dimensions. Aside from the question of size, however, I could not but ponder over the fact that the curvature of both of the smaller ones was just the reverse of that of the main dam. That is, their concave instead of convex side was faced in the upstream direction.

The first auxiliary dam, shown in the photograph, was about two and a half feet high, and backed the seepage water as a small pond against the toe of the larger one. The second, yet farther down stream and of still smaller size, bore a similar relation to the middle dam of the three. These two accessory structures are in each instance obviously measures of protection against possible erosion and undermining by leakage through, or the flow of water over the dams, for no spillways were in evidence, or other recognizable safeguard against times of flood.

The three dams were made entirely of peeled sticks, mostly poles of fir, alder, and poplar, the longest as much as six or eight or even ten feet in length. These were freshly cut as though felled recently at and near the site. What, if any, might be the system or plan of arrangement of these materials of construction within the body of the dams could, of course, be told only by the partial demolition of one of the structures. This thought or desire, however, never came to mind.

It could be seen from the exterior

INCHES DEEP BUT TOWARD THE CENTER OF THE LAKE IT WAS FOUR AND A HALF FEET DEEP

that these sticks and poles were mudded together, and plastered on the upper side with a mucky soil which had been lifted from the adjacent bottom of the pond. It was not a perfectly water-tight job, for trickles were coming through the main dam here and there at all levels, in total amount apparently ample, at this time of the year, to maintain a *status quo* in the level of the big pond against its upper face.

It would be of interest to know whether by constructive skill or vigilance on the part of its builders, or by other means not disclosed, a similar degree of control is exercised over the movement of the waters in other seasons of the year. Nothing is seen to indicate that such may be the case. Nevertheless, in every feature of his work the beaver is acknowledged to be so ingenious an animal, that to leave subject to even an element of chance the possible destruction of this nucleal structure on which the peace of his entire community depends, seems not in keeping with his reputation for sagacity and foresight.

Some day we shall learn, we hope, what provision is made for such an emergency. Perhaps in case of threatened or actual damage to his works, this animal depends alone upon an indefatigable industry to thwart disaster. And if destruction comes, he may do as humans do, rebuild, or cast about for a more propitious site on which to found a structure more substantial than the old.

And the beaver house? We had nearly given up before we found it. In the main pond some two hundred yards up from the dam it was, forty feet in from the water's edge among a sizable stand of drowned firs and hemlocks. Leading to it from the shore was a large down-fir which may, one might imagine, have served for the busy carpenters who built it, as it did for us, as a pathway along which to come and go. Being semi-aquatic in their nature, however, it is more likely that even this seemingly convenient log would be to them an obstacle rather than a help in bringing into place the materials of construction.

This beaver house was made of miniature peeled logs, twigs, and sticks, held in place by a plastering of mud, upon which among the final layers of thatching some green sod had managed to make a start. It was conical in outline and built symmetrically around a standing fir which rose as the center-pole of a tepee, out of its very apex. The water on the shoreward side, in August, stood eighteen inches deep above its base, while the greatest depth was four and one half feet toward the open part of the lake.

No life was seen about this place of residence, though in its environs were abundant signs of its immediate presence. Much-used beaver trails led to the water from the surrounding slopes in many places. Newly-felled trees were plentiful along the shores, many of them entirely too large to be moved on land, yet well above the highest high-water line. Some were only partly cut, then obviously abandoned; others were yet alive, at which the beaver ax-men were still engaged.

But amidst all this evidence of beaver activities, and while the camera was deliberately trained upon their works, not a rustle of the shrubbery or ripple in the water gave sign that our visit was recognized, not to say a welcome one. Neither was there token of resentment, though we cautiously and respectfully stood upon the roof of the house in which they dwell, sounded quietly the depths of

the pond in which they play, and walked carefully from end to end their dam, the nucleal feature of it all.

Our methods certainly could not be likened to those of one who is fully familiar with the habits of the beaver in his home, regardless of our innermost desires and expectations. I conceive that such a person might have shown us, at this very time, the object of our longing. As it was, however, we were destined to depart not completely satisfied, it is admitted, but with camera records well worth while, and the thrill of a yet unrealized desire whose fulfilment must await some future day.

Falls of the Clackamas River

The grass lands at Metto, an oasis in the bleak lava fields of Danakil where herds of milk camels, goats, and sheep feed on its borders. It is bounded on the north by monumental "ant" houses ten and fifteen feet in height

Through the Land of Sheba

By BARNUM BROWN
Associate Curator of Fossil Reptiles

ABYSSINIA, although but a fragment of ancient Ethiopia, is one-tenth the size of the entire United States and is one of the few remaining world empires. Centralized on mountainous highland plateaus of forbidding approach, surrounded by desert and sea, its self-contained people, approximately 8,000,000 strong, have for centuries remained cut off from contact with the outside world, where they have perpetuated a civilization that found inspiration in Solomon's court.

And it bids fair to remain an empire with Egypt at its back and flanked to the eastward by a fringing seacoast equally divided among British, French, and Italian possessions, each jealously protesting any encroachment upon the hinterland of the other. Lying wholly within the tropics, chiefly between 5° and 15° north latitude, its nearness to the equator is counterbalanced by the elevation of the highlands, so that the climate ranges from cool temperate on the plateaus to torrid in the desert in Dankaliland and the Haud of Somaliland.

In early times there was an intimate relation with Egypt and an extensive commercial intercourse with the Hebrews. According to tradition, the Queen of Sheba, who visited Solomon, ruled Ethiopia and from their son Menelek (second self) subsequent rulers have claimed descent. But the ruler in many cases has been recognized through force of arms rather than through purity of lineage, since during the last three hundred years the country has been composed of several provinces, each ruled by a feudal chieftain, some of whom have at times overlorded all.

Christianity was adopted about 330 A. D. and the country reached its greatest expansion in the sixth century, after which it gradually contracted through aggression of the Mohammedans until, as Gibbon says, "encompassed by the enemies of their religion, the Ethiopians slept for nearly 1000 years, forgetful of the world by whom they were forgotten."

Subsequent to the general invasion of northern Africa, followers of the Prophet encroached upon Ethiopian territory and mingled to a large extent with the Christians, especially in the lowlands where they are now dominant.

The outstanding figure of Ethiopian history is Menelek II, a leader of exceptional ability and a man in sympathy with the progress of the outside world. His name is recalled throughout Abyssinia today even as we speak of Washington.

At the death of King John (1889) Menelek proclaimed himself Negus Negusti (Emperor, King of Kings) and to his court most of the great powers sent representatives. During his reign Abyssinia developed slowly and became a crystallized, unified government, though functioning quite differently from any other modern government. In 1909, while the Emperor was seriously ill, his grandson, Lij Yasu, a boy of thirteen, was publicly proclaimed Menelek's successor.

The exact date of Menelek's death, some time in 1913, is unpublished, as are many other facts in this land of intrigue and feudal chieftainship. Lij Yasu was said to be a handsome, daring youth beloved by his people, who thought him an ideal successor of Menelek, but serious thought of his position and responsibility were secondary to him at this time. His advisors were not of the best, and during one orgy he was photographed in Mohammedan costume. This evidence was sufficient, with the aid of "Dame Rumor" and intrigue, to establish him as a full-fledged Mohammedan whose thoughts were of conquering the world for Islam. Such a thing was intolerable in a Christian country and Lij Yasu was outlawed. It is true that a large number of Lij Yasu's followers from the lowland countries were Moham-

The Regent Ras Tafari, foremost mounted figure and Queen Zaoditou surrounded by armed retainers as they entered Adis Ababa, returning from a religious pilgrimage to Mount Entoto

Eucalyptus-bordered street in Adis Ababa, with the palace buildings in the distance

medans, but his best fighting chieftains were Christians.

Among the opposing Christian chieftains Ras Tafari, Prince of Harrar, was chosen leader. He wisely refrained from proclaiming himself emperor and rallied the people to fight for Zaoditou, Menelek's daughter, to be made queen, Ras Tafari to be regent and inherit the throne after her death. Two bloody battles were fought, one by mutual agreement on a plain outside the capital to avoid destruction of buildings, a battle where men fired one round, threw away their guns and fought with swords, and at the conclusion of which, four thousand lay dead on the field. In both battles Lij Yasu's followers were defeated and he himself was driven into Dankaliland. In 1924 he was captured and imprisoned near Adis Ababa. And so we reach the present day when Abyssinia is actually ruled by a triumvirate, the Queen Zaoditou, the Regent Ras Tafari, and the *Abuna*, or Archbishop. Although the latter does not appear in government affairs, his opinion is equally expressive, for it is backed by many thousands of rifles.

The Abyssinians are of mixed Hamito-Semitic stock, in general a well-formed, handsome people with regular features, straight or kinky hair, according to admixture of negroid blood, and in color range from pale olive to sooty black. Slavery by purchase or capture is practised throughout the country, which accounts for considerable of the mixed blood, but the highland people resent any statement that they are not of the Aryan race and, since defeating the Italian army at Adowa in 1897, appear rather haughty to the white residents. Among the better classes civilities are courtly, verging upon ostentatiousness. One comes away from Abyssinia feeling that he may have visited descendants of one of the lost tribes of Israel.

The language, like the people, is of mixed Hamitic-Semitic origin. State

documents are written in Amharic, while Geez is used by the priests, and the spoken tongue consists of dialects of the old Hamitic language.

The Abyssinians are an agricultural people who, because of burdensome taxes which impoverish the industrious, produce only sufficient crops to sustain the family. Land is not held in fee simple, but is subject to the control of the State or Church.

I might say that fighting is a pastime, for every man is a potential soldier ready to take rifle and leave his field at a moment's notice. In general a feudal system is followed, and each officer contributes his given quota of men to the army.

Farms are usually of small dimensions, without fences, and cultivated areas extend far up on the mountainsides where the terraced plots cling precariously to the highest peaks. Indian maize and barley are cultivated extensively where soil and conditions are suitable. Teff, a kind of millet, is indigenous and takes the place of wheat in many sections. The grain is extremely small and when ground into white flour is very palatable—cooked usually in thin cakes like American pancakes. In the temperate lowlands, in places particularly suited to it, cotton is an important crop, for this country is free from the boll weevil. Coffee of superior grade is grown extensively in some parts; in fact, the coffee plant probably originated in the province of Kaffa.

In the highlands there is a considerable variety of fruits which, like the domestic animals, could be greatly improved by cultivation, but Abyssinians do not care particularly for fruit. The people usually live in small villages surrounded by stockades, and one rarely sees individual houses scattered over the landscape.

Their legal system is based upon the Justinian Code and the principles of the Mosaic Law are chiefly followed, but with right of appeal to the Emperor. For murder the death penalty is exacted, and in the market place of Adis Ababa there are several favorite

Abyssinians are decidedly argumentative and most questions of minor nature are settled at wayside courts to which all comers are eligible

trees where it is not unusual to see three corpses hanging, each with a placard below stating the crime and the reason for execution.

For conviction of theft an offender is fined. If guilty a second time he is fined heavily and warned of drastic punishment. If thrice convicted he is taken to the market place, where his right hand and left foot or his left hand and right foot are cut off. A witness of this terrible punishment may not aid the offender, or he too is equally guilty. Strange to say, some recover and regain their standing in society.

The Abyssinian church agrees in general with the Monophysite Copts in ritual and practice. Saints and angels are revered, but graven images are forbidden. Fasts are rigid. The Monophysites believe that Christ was one person, with one nature made up of an indissoluble union of a divine and a human nature, but that these two natures remained distinct, unconfounded and separate though insepar

The market place of Adis Ababa fascinates the visitor with its varied assortment of wares brought together from distant places. Old bottles, bits of iron and much used clothing are quite as important as black leopard skins, ivory and grain

able. On all other points of dogma the Copts agree with the Greek church. The *Abuna* or archbishop, is appointed from Egypt. The churches are usually circular in form, although in Tigre they are square or oblong, and for the most part the arrangements are based upon Jewish traditions.

The country has potential possibilities in agriculture but not for foreign development, and mineral resources likewise are difficult to develop under prevailing ideas.

An investigation of mineral resources afforded me the opportunity to travel over a considerable part of the coun-

Coptic priests dancing before the ark seen just in front of the tent. This ceremony is a yearly religious festival of great importance. On the hillside may be seen a native village

try when, granted a year's leave of absence from the Museum, I joined the "Dudley Expedition" to explore Harrar Province, and, thanks to the generosity of the Directors of the Anglo-American Oil Company, the American Museum secured an extensive collection of invertebrate fossils and ethnological and herpetological material from new or little-known areas.

From the Red Sea port, Djibouti, in French Somaliland, to Adis Ababa, the Abyssinian capital, is a journey of 500 miles through desert and lava fields on the plains and through picturesque mountain scenery as the highlands are approached—a journey that lasts two days, for the trains do not run at night.

Among high types of Abyssinians the women are completely covered by a loose flowing toga-like drapery of white cotton sheeting. The men are usually barefooted and wear white cotton-sheeting trousers. The heavy black native wool poncho coat is worn in the highlands, and during rain storms the peak above the left shoulder is drawn over the head

Following the usual mistaken custom of organizations that visit Ethiopia, the Dudley Expedition bore rich gifts to the rulers—a diamond necklace for the Queen, an electric-light plant for the palace, diamond watches, gold watches, a cinema, and smaller gifts for the chieftains. I say "mistaken custom" because frequently such gifts arouse the suspicion of the rulers. At the presentation I am sure that Europeans smiled as our party rode to the (Gibby) palace—men in full evening dress astride donkeys under a hot midday sun! Hordes of spectators lined the roadsides, as curious to our eyes as we were to theirs. The gates opened upon other throngs of white-draped figures, and finally we were ushered into the royal presence. Queen Zaoditou was seated amongst cushions and muffled to the eyes, Prince Regent Tafari seated near by. Ministers, officers and diplomats standing filled the room, making a picturesque, thrilling scene never to be forgotten. This was the official presentation, with many speeches and much salaaming. I rode away feeling that I had participated in a chapter from the *Arabian Nights*. Other audiences followed in which business was discussed, but it is extremely difficult for an Abyssinian to commit himself definitely, and an agreement which could have been consummated within an hour elsewhere required two months in Adis Ababa, where apparently the motto is "Never do today what can be put off until some time in the future."

But time did not hang heavily upon our hands, for besides sightseeing there was much to be done in caravan preparation—a small army of men to secure, drill, and train, mules to purchase for the highland journeys, and camels for the lowlands.

The capital is dominated by tall eucalyptus trees planted during the time of Menelek. Stone alternate with frame buildings, and mud-walled, grass-thatched *tukels* are scattered along irregular streets. The roads are never more than trails along which travel crowds of people walking to and from

A highland chieftain with two armed retainers each wearing the manes of lions they have killed. The shields are made of hippopotamus hide

the markets, with now and then a chieftain from some distant part on horseback, accompanied by many retainers on foot.[1] It was a daily panorama of intensely interesting scenes.

All things end even in Abyssinia, and just before our train pulled out for Diré Daoua a minister came with our belated caravan passport from the Regent. This much-prized document is quaint in diction:

"From Ras Tafari, Heir Presumptive to the throne of Abyssinia, to Dijazmatch Imourou: How are you? I am well, with the help of the Almighty," etc.

Its effect upon distant tribesmen was magical, producing instant compliance with our wishes even in the remotest districts.

Mules and horses were purchased and men hired in Adis Ababa, because the highland type of each is preferable and the range of choice greater. Half of the men selected were Christians and half were Mohammedans, so that in case of an argument the white men should retain the balance of power. Rarely has a caravan so well equipped and with such conveniences trekked through Africa.

A mule caravan in Abyssinia is like an appetite, it grows continually and is difficult to curb. We finally started with fifty servants trained and armed as soldiers, and sixty mules and horses. With a man leading each mule, single file, our caravan, a mile in length, was an imposing spectacle and an event wherever we traveled, furnishing a record date for the people long afterward.

Diré Daoua, on the railway, was headquarters. From this point a trail winds up the jagged limestone face of the Harrar plateau, 4,000 feet above the plain, then through fields of durra and maize to Harrar, which in size and importance is the second city of Abyssinia. Founded by the Arabs in the seventh century, it now contains a population of about 40,000 people. From a distance it is compact and imposing. The high ancient wall which surrounds the city is encircled in turn by a belt of refuse heaps and cemeteries which press closely upon it. Inside of the wall, buildings shoulder each other in precarious fashion along narrow, rough, cobbled streets which also function as sewers. Dead cats, bones, and refuse contribute to make Harrar

[1]Since Ras Tafari returned from Europe last year the roads in Adis Ababa have been repaired and at present there are about one hundred motor cars in the capital, mostly Fords.

the most evil-smelling and the dirtiest town on the face of the earth.

Westward from Harrar our route paralleled the Tschertscher Mountains. Their southern foothills are black lava peaks representing several distinct flows that abut upon the plateau. In these uplands, steep-walled ca ons a thousand feet deep trench the plateau every few miles, tributaries of the Webbi Shebeli, their fertile valleys producing abundant grain and excellent coffee. The people of this district are all "foot" men and their power of endurance is great. Our caravan averaged not more than from ten to fifteen miles daily, and it was not unusual for a messenger to cover as much in one day as we did in four. In the Gara Mulata Mountains there are antelope, nyales and bushbuck, but few fell victim to our guns, for primarily this was not a sporting expedition. Jackals howled on the hillsides every night and hyænas prowled about. One of the chief entertainments after dark was to give flash lights to the soldiers, who at a signal flashed them into the darkness, and when gleaming eyes reflected the light the white men would fire. One morning there were four hyænas lying a short distance from camp as a result of this practise, all so mangy that the skins could not be preserved.

At Dogou the Dijazmatch Vake, Governor of Gara Mulata, passed us, leading his army against a raiding party of the Mad Mullah's Somalis who had burned several villages, killing the men and carrying off the women and cattle. Vake made a successful trip and brought back a large number of prisoners, among them the Mad Mullah's father-in-law who had been leading the raid. It fell to our lot to give medical treatment to several of his soldiers.

A few days later, on reaching the Governor's headquarters at Grau, we were royally entertained at a banquet, where the native Abyssinians were given raw meat, which they prefer. For the white men, cooked meat highly seasoned with pepper and herbs was served in a common pot without knives or forks, but with plenty of thin teff cakes which took the place of tableware. Beakers of tej (fermented honey), and arraki, both national drinks, were served copiously during the feast. Afterward we presented the Governor with champagne and rum, which pleased him greatly, but he remarked, "It is rather a mild drink for a fighting Abyssinian."

Finishing the trek westward on the high plateau, our return route again passed Harrar on to the lower, more open plains of Djidjiga. Here we divided our company and I, with good old Hassan, a Mohammedan, as headman, seventeen picked riflemen, five camels, and two saddle mules, started for Hargeisa, British Somaliland, a journey of four days without water, where the camels must carry sufficient water for both men and mules. Eastward the plain gradually becomes more level and toward the international boundary line is covered with tall grass —a country of wonderful grazing possibilities, but mostly unused through lack of water. Thousands of gazelles were seen daily in herds of a dozen up to three hundred.

The Mohammedans would not eat food that had been defiled by Christian touch and *vice versa*, nor would either eat anything that white men had visibly handled. When shooting game, I would announce that this was a Christian or a Mohammedan animal, and when it dropped, two men of that faith would rush forward to cut the throat

The western part of Harrar Province is a white limestone plateau trenched every few miles by precipitous cañons, tributary to the Webbi Shebeli. All are erosional, and eons of time were required to sculpture them 600-1000 feet in depth

There are sizeable forests of deciduous trees in the Tschertscher Mountains, but at elevations of 4000–5000 feet on the plateau, *Euphorbias* take their place, some of giant size. Near Harrar they are planted as fences around the fields, and they border all the trails

An army of 3000 men under command of the Governor of Djidjiga protects the eastern frontier. It comprises infantry, cavalry, a camel corps, and artillery, the latter composed of one six-pounder mountain piece and one old Maxim gun which despite their feebleness are put into action quickly. Lack of rigid military formation does not impair the fighting quality of an Abyssinian army

This telephone station is a mimosa tree on the Harrar Plateau far from habitation. Necessity compelled us to use this amateurish line strung from tree to pole to tree, connecting a remote district with the capital, and at the end of the second day we had established speaking contact

before it died. If the animal had stopped kicking before they reached it, neither would eat the meat.

I quote extracts from my diary:

Dec. 3. Last night there was a fairly heavy dew and this morning the grass was quite wet, which explains why the gazelles

A tame hartebeest at Djidjiga. Mothered by a goat when orphaned, he thrived in the village, losing all fear and respect for man

and other antelope can live for months on these grassy plains without water. Traveled nearly all day in mimosa and acacia forests of low trees, passed many deserted zaribas of nomadic Somalis who herd over these areas during the rainy season. Cemeteries containing from one to twelve graves and enclosed by thick brush were passed at intervals all along the trail. Each may represent the season's dead of an itinerant village, or they may be family plots covering several years. There are so many that they arrest one's attention.

A Somali camel caravan with two men and two women arrived after dark, camping in the zariba with us for protection.

Our pack camels are marvelous beasts. They go without water four days and carry 400 pounds each. Their rhythmic, measured tread is exasperating to one in a hurry, but they are sure as heartbeats. When the loads are removed, they stray out among the trees, preferring the sparse leaves and thorns of the mimosas to the thick grass. When brought into the zariba (circular thorn enclosure) at night they are forced to kneel down, and with feet doubled under, each has his front legs tied so that he cannot rise. All are grouped close together, with their tails to the wind, the Arab drivers sleeping in front of them.

Dec. 4. Saw many more thousands of gazelles and one large antelope, probably an eland. At eight o'clock met a large camel caravan of Somalis without guns, but with a few spears. A lion jumped into their zariba last night and seized a sleeping man, but was driven off after the man had been mortally wounded. Lions are most numerous in this section near the international boundary. While camp was being pitched in an old zariba, I strolled out and saw a lion, but when the gunbearer arrived I had lost sight of it. We killed two sheep within ten feet of the zariba, and I instructed the guards to call me if the lions came during the night. There was one false alarm, and in the morning I found tracks of the lions within ten feet of my tent but they were not seen by the guard.

Just beyond the international boundary the quartzite hills of Doubbouro appear. Near these hills aloes begin in abundance and the entire fauna and flora change within a few miles. Apparently these hills are a part of the divide that separates the coastal fauna and flora from that of the high plateau region. In the aloes we saw dozens of beautiful little dik-dik, the smallest of antelopes, about the size of a jack rabbit, and usually in pairs.

A young Abyssinian lion.—The lion is symbolic of Abyssinia. He is a fierce, fearless beast, less stocky than the southern variety and with shorter mane

In the water holes at Djidjiga, thirty feet deep, five men are stationed, one above the other. The man below throws a basket of water to the one above and receives an empty one in return

Hargeisa is a Somali village with a shifting population of two or three thousand people, a wireless station, and headquarters for the British camel corps of native police. It is composed of two or three compact groups of grass-mat huts established here because of permanent water holes in the river bed. Immense trees (neems) are clustered in the river bottoms, some of the large ones shading an area nearly 200 feet square. Hyænas are numerous around the village and they frequently steal in and carry away babies and small children. Several deaths have resulted in this way. At this season there were two native gardens from which I obtained roasting ears, radishes and papayas, which shows what can be done with water. A cheap system of irrigation would have a far-reaching effect upon the natives.

In British Somaliland east of the Abyssinian boundary, a short camel-day's journey, there is a low chain of quartzite hills, part of the divide that separates the coastal flora and fauna from that of the plateau region. Near these hills aloes begin in abundance and the entire fauna and flora change within ten miles

From Hargeisa I returned to headquarters at Diré Daoua and re-outfitted with the same guards and headman but different camels for a journey to the northern plains at the foot of the Harrar plateau.

MULE CARAVAN ON THE HARRAR PLATEAU

A forested section at the foot of the Gara Mulata Mountains, lava masses that at a distance resemble stratified rocks. In the foreground is a section of our main mule caravan

ground is a section of our main mule caravan

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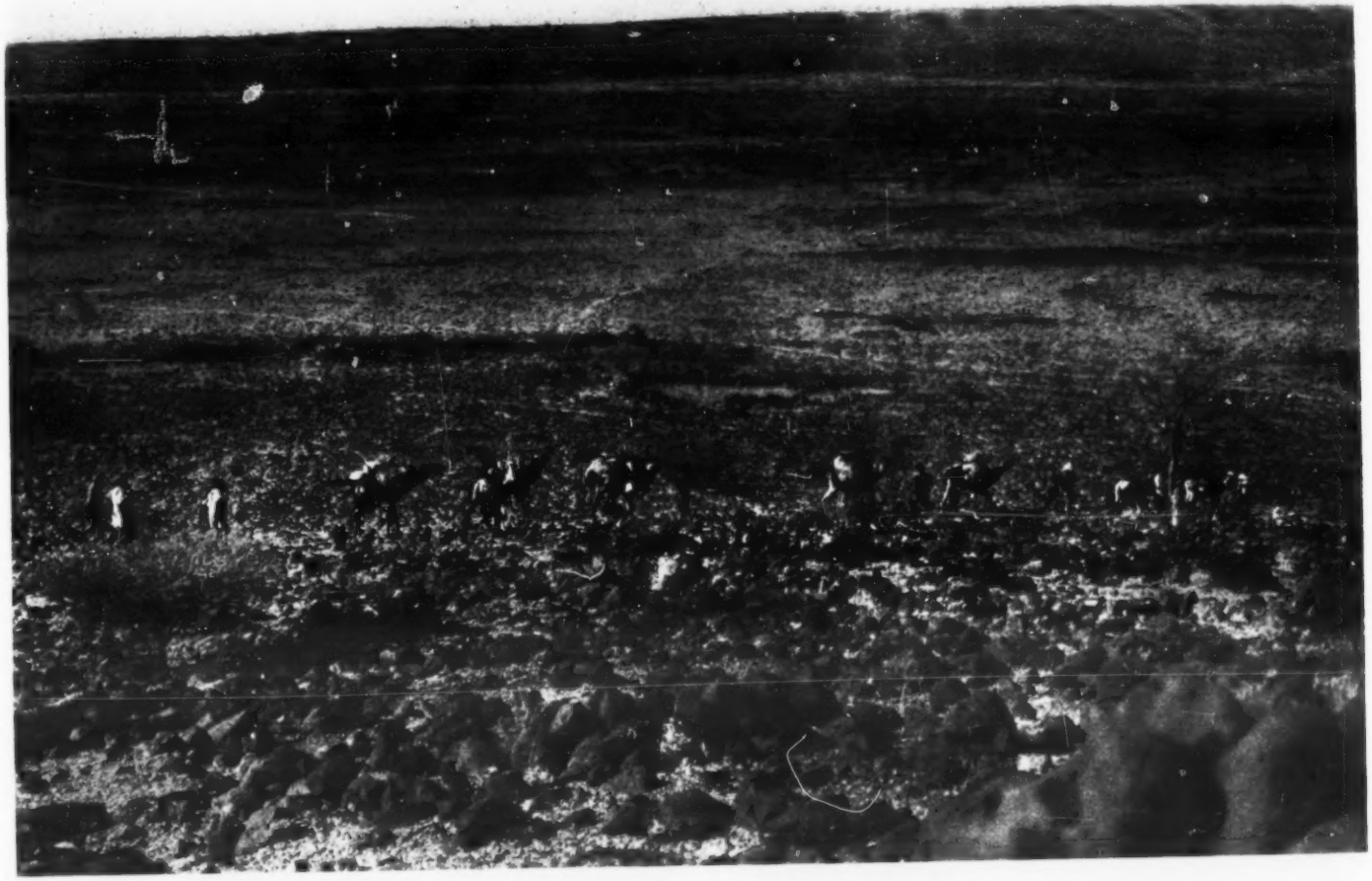

MY CAMEL CARAVAN IN THE DANAKIL LAVA FIELDS

East of the Harrar Plateau, in less than five miles all sedimentary strata completely disappear, covered by lava that has welled up through the great rift fracture. Here trails are merely discolored streaks over the sharp lava blocks where our average rate of travel was 1½ miles an hour

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Again I quote from my diary:

Dec. 29. Followed up a valley and then on to the lava cliffs and level plateau covered with low, scrubby thorn trees—the Gorgouro Somali country, a very poor herdspeople, much lower in development than other tribes of Somalis. Their mat houses are never more than four feet in height and are very mean in appointments. It is not a numerous tribe. The lava trails are extremely hard on the feet of the camels and mules, and we rarely accomplished more than a mile and a half an hour. . . Saw three wild boars, many gerenuk and gazelle. Killed one wild boar weighing about three hundred pounds, taking head and hams—an exciting experience. The Mohammedans of course would not touch it, nor are the Christians allowed to eat pork except under certain conditions. Two of my men who were *croix-de-guerre* soldiers during the great war and who had learned to eat pork in France, took advantage of the fact that the taboo on food is lifted in case of illness, and conveniently became sick.

Dec. 30. Came to a wonderful tall-grassed district called Metto, where the grass completely covered the mules as we rode through. Here were great herds of milk camels feeding around the edges and out on the plain. Camel's milk is the exclusive food and drink of many nomadic Somalis, and I found it more palatable than cow's milk. Not far away there are immense termite turrets, some fifteen feet high and ten feet in diameter. Thick timber lies to the west of this depression where there are many Issa and Somali zaribas and huts on the border of the forest.

Jan. 1. Left camp for Donkaliland, accompanied by a heavy guard. Our Gorgouro guide would not go with me for fear of the Donkalis. Traveled eleven hours to the distant hills in Donkaliland on the edge of a local lava flow that has come from the northward. Deserted Donkali houses made of lava are scattered around the edge of this flow. This is disputed territory fought over by Issas and Donkalis. A magnificent mountain, evidently an extinct crater resembling Mount Tacoma, rises majestically out of the plain west of us. This peak, fifty miles distant, is many thousands of feet in height. None of my people knew its name. Saw ten ostrich, magnificent birds, a half mile distant, but could not stalk them. Measured the tracks of one, which showed an eight-foot stride. Saw one lone oryx of a large species seen also near Djidjiga, and about thirty half its size, several hyænas and jackals. On our return to camp we were mistaken for Donkalis and a number of Issa warriors came out to fight us. When they discovered that I was a white man they wanted baksheesh. Passed villages at Metto, and the Issa women were very indignant when I photographed them.

Finishing this short journey, I returned to headquarters, because my camels were worn out in the lava fields, and with a new caravan again went into the lava field west of the railroad at Addagalla. The Somali camel men were very inferior to the Arabs. The second day after leaving the railroad we were joined by a prominent chief known to Hassan, and superior to all the Issas I had seen—tall and stately, with an intelligent face, keen eyes and a bushy head. An impressive individual. On his right arm, above the elbow, he wore a large elephant tusk bracelet, signifying that he had killed more than ten Donkalis. One of our young camel drivers wore a brass bracelet, which signified that he had killed two Donkalis. Passed through some shallow depressions in the lava field, where there were fragmentary bones and teeth of *Elephas* of Pleistocene age, but nothing worth collecting.

Jan. 8. Went down a deep, steep cañon tributary to the Hawash, to a deep water hole described to us by the Issa chief. We reached there at four A.M. Saw hippopotamus tracks on nearing the water hole and followed them to the pool. Presently I heard splashes and grunts from the rushes and spied a hippo just as he became submerged, but could not get a shot. Although we stayed there five hours, he never came up. The natives say that the animals sometimes remain submerged all day.

This was a beautiful pond of water two hundred feet long by thirty wide, fringed with cat-tail rushes and tall plumed grass. I spent the rest of the morning fishing and longing for dynamite. Caught seven large catfish. Fishhook and line were a sight of great interest to the large number of natives who collected along the bank and watched. They had never before seen fish caught in this manner.

Jan. 9. Trekked nine hours—the longest day of the season; a terrible heat with mirage distorting everything; lakes and rivers of water in all directions, but not a drop to drink. This is the time of the "Ramadan," the Mohammedan month of fasting, when none may

eat nor drink while the sun is above the horizon. Every Mohammedan carried his wooden water bottle and a leather prayer rug. He washes his hands and feet at the hour of prayer, but not a drop of water passes his parched lips. This was a long day and all the men were famished. Hassan had to beat them away from the water cans and ration the water, for they are thoughtless of tomorrow. Ten natives drank a camel can of water (eight gallons) at one sitting.

Jan. 10. Climbed up to the top of a lava flow and traveled until we came to the edge of a cliff bordering an old lake, Debu, many miles in extent, but now dry except in the rainy season—a wonderful sight. The walls surrounding this lake are three hundred feet high and in places are eroded into columnar form. In cross section the mass appears to be made up of lava flows of successive dates and of different constituency. A few natives were camped along the rim and as soon as they saw us in the distance all the men and young women ran away with their herds of goats, fearing that we were Abyssinian tax collectors. At one end of the depression are the hot springs of Takale. Here the natives come from many miles' distance for water.

Jan. 14. Rode toward Mount Marmar—brilliantly colored peaks or volcanic plugs, but there is no flow of lava near by. These beautiful peaks are most weird and picturesque, in brilliance of color rivalling Turner's sunrise scenes of Venice.

As the caravan was strung out today, the men in advance scared three wild boars in a ravine, one as tall as a burro—a magnificent beast and larger than any I have ever seen or read of. As soon as my gunbearer reached me I spurred after them at top speed into the wood, but never got a shot.

These incidents of travel are introduced to show the nature and conditions on the plains of Danakil at the foot of the great Harrar plateau where 4,000 feet of displacement were measured and where within a distance of five miles the faulted blocks of plateau limestone completely disappear, engulfed in lava.

The eastern part of Abyssinia is drained by the great Hawash, a river that in size equals the Delaware. It rises in the highlands and flows northeastward, following the general trend of the great Rift, a part of that profound geologic movement that separated Africa from Arabia. In the lava-covered plains of Danakil the Hawash rushes through a steep-walled cañon and in its lower reaches spreads out into a series of lagoons; a small part of it reaches Lake Aussa, but none of its water empties into the sea.

Some of the men who had visited the marshland around these lagoons described it as a region of big game, with hippopotamus, rhinoceros, zebra, and the larger antelope in considerable numbers, a field that would furnish much valuable information upon the modification of species in a restricted habitat.

Since historic times the distribution of big game in Abyssinia has been greatly changed. Elephants and rhinoceroses, formerly numerous as far eastward as Diré Daoua, are now found mostly in the west, especially in the Sobat valley. The hippopotamus is also found, chiefly in the western rivers, and likewise the giraffe, while the ass and zebra usually appear in the highlands bordering the Sudan. Wild boars are still fairly numerous in the lowlands at the foot of the Harrar plateau, while nearly all members of the antelope family of northern habitat are found in the eastern lowlands of Abyssinia. Leopards, spotted and black, are numerous in the mountainous highlands; hyænas and jackals are common through nearly the entire country. Lions are now most numerous in the eastern lowlands and the Haud of Somaliland, although they formerly had a much more extended range. The lion is the national emblem of Abyssinia, and Menelek II, great king of this country, fittingly signed himself "The Lion of Judah has conquered."

Reviews of the Recent Work of Australian Mammalogists

By H. C. RAVEN
Assistant Curator, Comparative and Human Anatomy

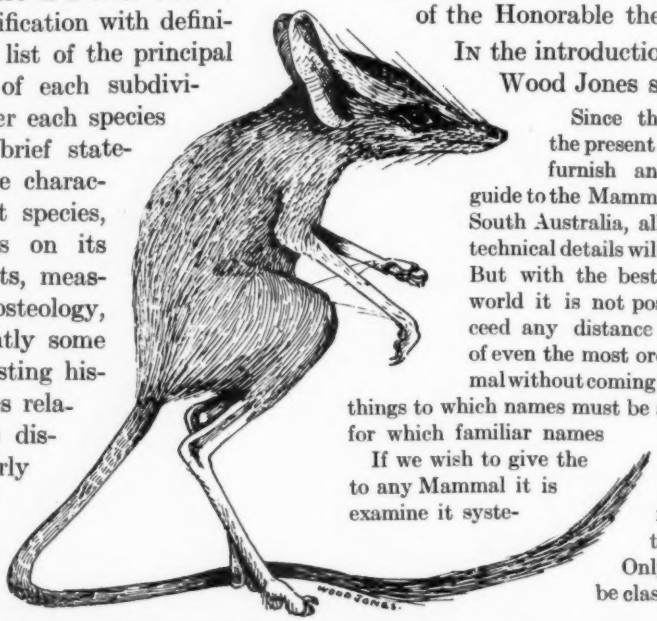
The Vertebrate Animals of Tasmania. By Lord and Scott. Oldham, Beddome and Meredith, Hobart, Tasmania, 1924. 8vo., pp. 1–340.

THIS is a volume of convenient size which will prove to be a great help to anyone interested in the vertebrates of Tasmania. Nearly one hundred pages are devoted to the mammals, which include monotremes, marsupials, and placentals. The majority of the genera of mammals listed from the Island State of the Australian Commonwealth are cetaceans and pinnipeds, though the greater number of the terrestrial mammals belong to the Marsupialia. At the beginning of the treatment of each subclass there is a brief outline of the classification with definitions, or a list of the principal characters of each subdivision. Under each species is given a brief statement of the characters of that species, some notes on its range, habits, measurements, osteology, and frequently some very interesting historical notes relative to the discovery or early records of the animal. An attempt has been made to picture the greater number of the land mammals, but unfortunately the illustrations are very poor. As a synopsis of the vertebrates of Tasmania the work is a most welcome one, containing much valuable information for all students of the region.

"The Mammals of South Australia," by Frederick Wood Jones. Part 1—The Monotremes and Carnivorous Marsupials, 1923, pp. 1-131. Part 2—The Bandicoots and the Herbivorous Marsupials, 1924, pp. 133-270. Adelaide. "A part of a series of *Handbooks of the Flora and Fauna of South Australia*, issued by the British Science Guild (South Australian Branch) and published by favor of the Honorable the Premier."

IN the introduction Professor Wood Jones states:

> Since the purpose of the present volume is to furnish an elementary guide to the Mammals inhabiting South Australia, all unnecessary technical details will be excluded. But with the best wish in the world it is not possible to proceed any distance in the study of even the most ordinary Mammal without coming across certain things to which names must be assigned, and for which familiar names are lacking. If we wish to give the proper name to any Mammal it is necessary to examine it systematically and to measure it. Only then can it be classified, and its



Antechinomys spenceri, two-thirds natural size. One of the 190 admirable text figures from *The Mammals of South Australia* by Wood Jones. Among the Australian marsupials hopping forms have developed in three distinct families: the kangaroos, the bandicoots, and the dasyures,—to which *Antechinomys* belongs

identity finally settled. Certain features require special examination, since all parts of an animal are not of equal importance in the determination of its status. Here we will be almost entirely concerned with external characters, but it must be remembered that these external characters are not in themselves sufficient to diagnose, beyond all doubt, the proper position of an animal in the scale of nature. Other, deeper, and more complex details must be considered. Nevertheless, external characters alone will lead a long way, and it is, therefore, worth while to pay some systematic attention to them.

The remainder of the introduction is devoted to a very clear exposition of the characters of use to the student in determining the taxonomic position of the various mammals, how to measure them, etc.

Under the heading, "The Classification of the Mammals," the author defines the three subclasses, Ornithodelphia, Didelphia, and Monodelphia, and illustrates each by means of a very clear diagram of the female reproductive system.

Another section is devoted to "Special Problems Connected with the Mammalian Fauna of Australia." In this the author discusses and briefly reviews some of the theories of the origin and dispersal of the mammals of Australia. Regarding their migration, the author's views are in agreement with those of the famous zoögeographer, Alfred Russell Wallace. In the concluding paragraph of this section, Professor Wood Jones makes a plea for the Australian mammals in the following words:

> Every member of the fauna is worthy of study for its own sake, and around the whole assemblage of species is woven a meshwork of the grandest and most important biological problems. In the Ornithodelphia and the Didelphia, Australia has a heritage for which it must accept responsibility; it must be prepared to conserve the living, to collect and preserve the dead, and to make provision for the proper study of the fauna in all its aspects.

All vertebrate zoölogists realize the importance of Professor Wood Jones's statement and many of them have endeavored to bring about measures for the protection of the Australian mammalian fauna, the principal enemies of which are, at the present time, the people engaged in killing and exporting the skins of these mammals, that is, the skin and fur trades; and the animals introduced into Australia by man, which have become feral and overrun much of the country.

The two parts of this work, which have been received together, contain 270 pages and 190 text figures. All the figures are reproductions of pen drawings from the actual specimens by the author. The figures are admirable illustrations, serving to compare the various animals and, what is most important, to show their morphological characteristics.

"The Zoögeography of Marsupials." By Heber A. Longman, F. L. S., Director, Queensland Museum. Mem. Queensland Mus. 1924, VIII, part 1, pp. 1-15.

In this article Mr. Longman very ably reviews the literature bearing on the marsupial fauna of the Australian region, its origin and distribution, past and present. He first considers the views of such eminent writers on the subject as Mr. H. O. Forbes, Sir Baldwin Spencer, the late Professor Haswell, and Mr. Charles Hedley. Then in turn are considered the families of recent polyprotodont marsupials—Dasyuridæ, Peramelidæ, and Notoryctidæ, with notes on the distribution of, and evidence to be deduced from, each group. Under the heading "Diprotodontia" is given a brief summary of the distribution of this group, with the names of recently

described genera, most of which occur on the islands of the Indo-Australian Archipelago, to the north of Australia. Special paragraphs undertake a resumé of the following: Tasmanian Fauna, Syndactylism, Fossil Marsupials, Myrmecoboides, South American Fossils, and Wynyardia. Under the heading "Brief Notes on the Non-Marsupial Fauna" the Monotremes, Rodentia, Reptilia, Amphibia, Fishes, and Flora are discussed with regard to the part they take in relation to the distribution of the marsupials.

The following paragraphs from the latter part of Mr. Longman's paper will give an idea of this involved problem.

The assumption of a continent in the Antarctic in early Tertiary times, in order to account for related elements in the faunas and floras of South America, Australia, New Zealand, various Pacific Islands, Madagascar, and South Africa has proved a veritable Pandora's box to biologists. In order to explain many of the difficulties raised, it is suggested that this circumpolar area had radiating land bridges, inconstant in direction and dimension, apparently reaching out on the one hand to deposit certain types in Pacific archipelagoes; elsewhere stretching to Madagascar to transfer iguanas; extending to New Zealand to allow other forms to gain new land; and independently reaching Tasmania to enable the ancestors of our marsupials to complete a trans-polar journey and find a congenial refuge.

The presence of more extensive land areas in the Antarctic in Mesozoic times is apparently demonstrated, but it seems improbable that these areas were faunal land bridges for vertebrates. On the other hand, the presence of "ancient continental" islands to the northwest, as shown by Russel Wallace in *Island Life* and the *Geographical Distribution of Animals*, is undoubted. That the evidence of these "ancient continental" islands is incomplete is doubtless due to partial or entire submergence. In this connection it is interesting to note that Weber and Beaufort (1912) in their analysis of the fresh-water fishes of Timor found that this fish fauna was "almost totally composed of immigrants from the sea," the inference being that the island had been largely submerged in Tertiary times.

Possibly fossils from the Austro-Malayan-Asiatic regions will one day be forthcoming to strengthen the view that our marsupials had a northern origin probably before "Wallace's Line" had significance as a partial barrier. But even on existing evidence, it seems to the writer that the alternative route of Antarctic land bridges involves us in far greater difficulties and anomalies.

Mr. Longman's views for the most part are in agreement with those of the greater number of students of the zoögeography of marsupials. His paper, containing an extensive bibliography, is a valuable contribution to this very interesting subject.

BESIDES the papers already reviewed there are many others of interest. Professor Launcelot Harrison of the University of Sydney has published, 1924, *Australian Zool.*, III, part 7, pp. 247-63, a paper on "The Migration Route of the Australian Marsupial Fauna," in which he comes to conclusions about the opposite of those reached by Mr. Longman on the same subject.

Professor T. Thomson Flynn of the University of Tasmania has contributed a number of papers on the embryology of the marsupials. Messrs. Scott and Lord of Tasmania have written several papers on the fauna, fossil and recent, of the Island State; their papers are usually to be found among the *Papers and Proceedings of the Royal Society of Tasmania*. From the Australian Institute of Anatomical Research, Melbourne, come some papers on the comparative anatomy of the monotremes and marsupials by Dr. William Colin MacKenzie.

Mr. Harry Burrell, who is very widely known as one of Australia's foremost students of the life history of the monotremes, has contributed articles to the *Australian Zoologist* and other

publications for the past several years. The titles to some of [illegible] articles in the *Australian Zoologist* are as follows: "The Deposition of the Eggs of Monotremes" (1917, I, part 4, p 87); "Field Notes on the Life History of Monotremes" (1920, I, part 8, pp. 231-40, text figs. 1-6); "Preliminary Note on the Breeding of *Ornithorhynchus* in 1920" (1921, II, part 2, pp. 20-23, Pls. I-II); "Note on Some Natural Habits of Echidna (*Tachyglossus aculeatus*)" (1924, III, part 7, pp. 268-69); "Practical Observations of *Ornithorhynchus* Beneath Water" (1925, IV, part 1, pp. 4-7, Pl. II, figs. 2 and 3); "Field Notes on Natural Habits of Echidna, (*Tachyglossus aculeatus*)" (1925, IV, part 1, p. 8). Mr. Burrell's articles contain a quantity of interesting original information about the subjects he has chosen for his studies.

Among other writings of Mr. Burrell is the following verse, which has been published in the *Australian Museum Magazine:*

THE MUD-SUCKING PLATYPUS: A BRIEF HISTORY

BY HARRY BURRELL

O! thou prehistoric link,
Kin to beaver, rooster, skink,
Duck, mole, adder, monkey, fox,
Palæozoic paradox!

Beak of shoveller, spur of fowl;
Cheek of monkey (pocket jowl);
Trowel of beaver, gait of skink;
Dope of adder, foxy stink.

Mode of digging a la mole,
Fur much richer on the whole;
Feet palmated, ditto paws;
Latter webbed beyond the claws.

Swimming, diving, most expert,
Wary, nervous, cute, alert.
Food—aquatic creatures (small),
Sediment, and mud with all.

Ear and eyelid all in one;
Young have true teeth, adults none;
Snarls like cheeky pups at play;
Bites like gander when at bay.

Adult female spurless quite;
Teatless udder—contents white;
Egg-producing, capsules soft;
One to three, but two more oft.

Epipubic bones support
Dimpled abdomen; in short,
In that slight depression she
Incubates her progeny.

Warmth increased for eggs and young
By her tail, well underslung;
Snugly cuddled to her breast,
Mother nature does the rest.

Day-old youngsters in the nude,
Beakless, sightless, contour crude;
Sleep essential, rapid growth,
Spurs project in sexes both.

Mother's duties never done;
Father's (when not flirting)—none;
Hail! O paradox supreme,
Prehistoric Monotreme!

Ornithorhynchus anatinus, the Australian duckbill.
Negative owned by the New York Zoological Society

NOTES

THIRD ASIATIC EXPEDITION

THE THIRD ASIATIC EXPEDITION of this year was larger and its program more ambitious than in either of the preceding years. It was, in fact, the largest land expedition of a similar character that has ever gone into the field.

The American Museum was represented on the staff by Mr. Roy Chapman Andrews, Leader; Walter Granger, Charles P. Berkey, Frederick K. Morris, Clifford H. Pope, N. C. Nelson, and George Olson. Those on the staff not of the Museum were: Ralph W. Chaney, J. B. Shackelford, J. McKenzie Young, Norman G. Lovell, Tzokto Badmajopoff and others,—40 men all told, 12 Americans, 2 British, 14 Mongols, and 12 Chinese. The sciences represented were palæontology, archæology, geology, botany, topography, and photography.

The means of transportation were 125 camels, 5 motors, and two one-ton motor trucks. The camels left Kalgan, China, on February 15, carrying 3500 gallons of gasoline and food for the party of forty for five months. The camels were to await the motor party 700 miles from Kalgan, in the center of the Gobi Desert. The Scientific Staff left Pekin April 15. The Expedition traveled 5000 miles in the Gobi Desert, along the northern and southern bases of the Altai Mountains, west beyond the longitude of Uliassutai. Twenty-two thousand miles of this journey was exploration in a new country.

The results secured this year are the most important scientifically thus far obtained by the Expedition. For the first time archæology added to the value of the investigations made. In the Gobi Desert were discovered two Palæolithic (or Old Stone Age) human cultures and one Neolithic culture. Such widely separated horizons indicate that the whole chapter of Stone Age history may be deciphered in Asia as well as in Europe. It follows that light can be thrown on the origin of primitive races of the world and their migration if the investigations in Asia can be further prosecuted.

While no bones of members of primitive races were found this year, the scientists of the party are convinced that in some localities such bones must have been preserved and will eventually be found. Crude stone scrapers of Mousterian type were found, which in Europe are contemporaneous with Neanderthal man.

A late Palæolithic culture, somewhat corresponding to the Azilian culture of Europe but probably twice as old was discovered. The party named these people the "Dune Dwellers" because they inhabited the sand dunes on the shores of ancient lakes. They date back some 20,000 years. The remains consist of old fireplaces containing ashes, bits of charred bone and wood, together with thousands of flint chips, scrapers and drills.

A Neolithic, or New Stone Age culture was evidenced by stone arrow and spear points, finely worked scrapers, flint knives, and crude hand-made pottery.

The belief that Central Asia was the point of origin for much of the mammalian and reptilian life of the world has been greatly strengthened by these recent discoveries, for example, the evidence of the existence in Mongolia of several great groups of mammals which hitherto have been known only as from Europe or America. Also forty more dinosaur eggs, some ten million years old, have been found. In its search for dinosaur eggs, the party took as its slogan "Bigger and better eggs," and 12 eggs in one nest are finer than any previously discovered. Further, several new types of dinosaur eggs were found. New and very perfect skulls and skeletons of dinosaurs were collected and the scientists were able to make out the complete story of why and how the dinosaur eggs were preserved in this locality.

Six skulls of Cretaceous mammals were found in the dinosaur egg strata. Mammals were extremely rare in the Cretaceous Age (Age of Reptiles). With a single exception, these are the oldest mammal skulls in the world. They represent transitional steps in the evolution of mammals from reptiles.

The feet and part of the legs of the largest mammal that has ever lived (the giant *Baluchitherium*) were discovered. Approximately three million years ago the huge beast sank in quicksand and was fossilized in an upright position.

The skull of a strange double-horned animal, entirely unknown to the scientists of the party, was found. New and exceedingly rich fossil fields were discovered where the skulls, jaws, and bones of countless animals lie interlaced.

The scientific party of the staff determined that Mongolia is the oldest continually dry land in the world; that it has been a contin-

ously dry continent since late Palæozoic times, probably for twenty million years; that in Palæozoic times a great sea way extended through the Central Asia plateau from the Caspian to the Pacific; that the Central Asian plateau was never invaded by an ice sheet similar to that of Europe and America; that there was a "climatic cycle" in Mongolia. In other words, there were successive wet and dry periods with an ever-increasing aridity; that during the last 50,000 years the drying up has been rapid. These scientists have further discovered that in Oligocene times, about three million years ago, a vast redwood forest extended in Manchuria from Mukden almost to Vladivostock. The trees of this forest were similar to the giant redwoods of California, and the redwoods were accompanied by other trees, alder, maple, and oak.

A collection of several thousand living plants, well representing the flora of Mongolia, was made. Thousands of specimens of fish, reptiles, and mammals were taken, many species new to science being among them.

An accurate survey route from Kalgan, straight through the center of the Gobi Desert for more than a thousand miles, has been run. The most accurate maps ever attempted have been made.

Twelve thousand feet of a motion picture film have been made, showing among other things, a herd of 50,000 antelope and 1000 wild asses. Also many thousands of still photographs have been taken.

When the party returned to Peking on September 15 it found widespread news reports to the effect that the party had been expelled from Mongolia, it being falsely stated that the party was responsible for political propaganda, had made military maps, and had not adhered to its agreement with the Mongolian Government.

When the leader of the Expedition, Mr. Roy Chapman Andrews, left Urga early in June, his relations with the Mongolian Government were on a cordial basis of coöperation. He took with him two Mongol officials who were to learn the methods of field work and to see the localities where the Expedition had discovered fossils. One of these men remained with the Expedition and assisted in passing the customs at the frontier between Outer and Inner Mongolia.

The Expedition had written permission from the Mongolian Government to make the itinerary and locality maps, as well as to pursue all the investigations which it carried on. The Third Asiatic Expedition has never concerned itself with the politics of the countries in which it has carried on its explorations, and never will. To do so would, indeed, be the height of folly. The party is not made up of politicians, but of scientific explorers.

THE VERNAY-ANGOLA EXPEDITION

The Vernay-Angola Expedition has been brought to a successful conclusion and Mr. Vernay has returned to the United States. Mr. Vernay was accompanied by Messrs. Lang and Boulton, who made large and important collections. Mr. Vernay succeeded in shooting splendid specimens of the prized great sable antelope. The material, which has been already received at the Museum, includes more than 1500 mammals, 1300 birds, 3000 reptiles and batrachians, 2000 fish, besides many mollusks, crustacenas, insects, and Cretaceous invertebrate fossils.

In the following note Mr. Vernay narrates briefly the capture of the sable antelope:

"Our purpose was to obtain a group consisting of two bulls, two cows, and a calf. Unfortunately the time we had chosen to hunt for the sable was not the most appropriate, as one should hunt them between the 15th of September and the 1st of January. In the second half of September there are intermittent rains and the serious rains begin early in October, which makes tracking quite simple; whereas the only time we had at our disposal was the first two weeks in August. Consequently the ground was very hard and dry and it was impossible to track at all. Apart from this, the country had recently been burned over and in only a few places had the young grass begun to grow, with the result that feeding spaces were few and far between.

"Our first three days in the sable country were wasted, owing to our being misinformed by natives that sable had recently been seen in the district. After using up these three days in scouring the country, no tracks of sable were seen at all. We moved deeper into the country and camped on the Teti River near Chisongue, where the salt pans are situated. In the meanwhile we had picked up a very savage-looking native named Tarti, who had a great reputation as a hunter amongst the various tribes. As Tarti would pass through a village, the headman would come up, clap his hands, and say, 'Ohosie, Ohosie,' whereupon the hunter would reply

Specimen of Varian's sable antelope secured by Mr. Arthur S. Vernay

'Ondombo, Ondombo'—meaning that he was greeted with 'Lion, Lion,' and the reply was, 'Great, Great.' They thereupon would smile and clap their hands three times as greeting.

"I found it necessary to discard Tarti after a time, as he would not crawl over open spaces on account of the stubbly burnt grass; also he was continually taking snuff and making so much noise with sneezing and coughing that he was a bad man to have in a country where the animals are as shy as the sable antelope.

"I had with me young Alan Chapman who was born in Angola. It was for his grandfather that the Chapman zebra was named. Our plan of attack was that Alan should go north and I south, he go west and I east, or whatever arrangement might be best so that we should cover the whole country as much as possible. The first day out I was rewarded by getting two cows, one old cow and one young cow who had had one calf. The next day a calf was the bag.

"Two days after that Alan obtained a young bull with 39-inch horns. And time went on—and our anxiety increased as we now had only three days left; I decided to send Alan to camp on the Tunda River, which was about 15 kilometers away, as only a few days before I had seen tracks of a large bull which I thought he might possibly find. In the meanwhile I covered another part of the country. The understanding was that he was not to return until 9 o'clock of the morning we had to break up camp. This would allow him a few hours after daybreak to make a final hunt before reporting.

"I had no news from Alan and finally had only one day left. After having made a fairly thorough inspection of the country, I considered it almost useless to go out the last day—the natives' feet were in bad condition

and we were all tired—but finally I decided that we would make one last attempt and make a big detour around a feeding ground where I had seen a large bull at dawn a few days previously.

"I started out at a quarter to five with Sakafuta, an Ombundu native, and one other. At a quarter past seven I saw to the left, about 150 yards in the bush, a magnificent bull sable walking majestically through the bush returning from the feeding ground. Sakafuta and the other native had not seen him as they were looking in the other direction. However, at a signal, they immediately went down on the ground and disappeared in the grass, which was up to our waists. The bull in the meanwhile disappeared behind a large dead tree which had fallen. It was an anxious moment, wondering whether he would keep on or possibly turn away into the bush, which would mean that I should have to move and he probably would see me. However, he fortunately came out from behind the tree and was shot. In this way a magnificent specimen was obtained, which completed the group of the sable antelope.

"Sakafuta literally danced for joy, clapping his hands to his chest and smacking himself on the head. I had sent the other native back to camp for my camera, and Sakafuta sat down and jabbered to me for half an hour, such was his delight not only that we had obtained the bull, but I think he had also a little contentment realizing that his tramping was at an end.

"The sable area is limited, being between the Cuanza and Luando rivers, and is roughly 40 miles across and 80 miles long. Unfortunately the country is gradually being opened up, the railway has at last reached the Cuanza River, well north of our ground, and in time, I fear, this superb antelope will disappear, unless stringent laws are made limiting the number that a sportsman may shoot, and also making it an offense to sell or buy horns."

BIRDS

Two More Pink-headed Ducks (*Rhodonessa caryophyllacea*) have been presented to the American Museum by Mr. Alfred Ezra, the well-known aviculturist of Foxwarren Park, England, since the last number of Natural History went to press. They are a male and a female obtained alive with several others for Mr. David Ezra of Calcutta. These two ducks died in captivity, and two others escaped, it is said, in the harbor of Calcutta. Of those which reached England alive, Mr. Alfred Ezra now writes us that he has a drake and two ducks in fine condition; and so with luck he expects to be able to breed them next season.

The arrival of these ducks in England is an event of great interest to aviculturists. Very few have ever come to aviaries in England, one pair in 1874, and a few more in 1897, but none in recent years.

The exact spot where the birds were captured has of course not been revealed by the Indian bird-dealers, but it is probably in somewhat the same region of northern India where the specimens were obtained for the Faunthorpe-Vernay Expedition.

Our two specimens from Mr. Ezra are mounted, and excellently preserved. Even if the pink-headed duck is doomed to ultimate extermination, the American Museum will possess ample material to illustrate its unique coloration and other peculiar characteristics.

CONSERVATION

Protection for the Big Game of the Belgian Congo.—Early in 1924 a society known as the Cercle Zoologique Congolais was formed by the zöologists of the Section of Natural Sciences in the Congo Museum at Tervueren, Belgium, together with a number of other men specially interested in the Congo. The aims of the society include the study of the fauna of the Congo, the gathering of specimens for the Congo Museum and the Antwerp Zoölogical Garden, the popularization of the results of this study, and the protection of the fauna wherever necessary. Among the honorary members of the society are President Osborn and Messrs. Lang and Chapin of the American Museum.

The *Bulletin* issued by the Cercle during the past two years has been filled with notes and articles of value both for the zoölogist and the colonial administrator. Under the leadership of Doctors Schouteden and Derscheid an intensive campaign has been opened on behalf of the big game of the Congo, particularly the elephant and some mammals of greater rarity, such as the okapi, the white rhinoceros, and the gorilla, menaced by the increasing activity of civilized hunters as well as by the incessant persecution by natives.

To the sanctuary for gorillas in the Kivu volcanoes, first advocated by Mr. Carl E. Akeley of the American Museum and now

happily established by King Albert, the Cercle Zoologique Congolais gave its full and enthusiastic support. It offered to the Minister of Colonies the expert counsel of Belgian zoölogists, especially those most familiar with the Congo fauna, in projects for its protection.

Some of the members of the Cercle, now in the Congo, are writing for the *Bulletin* on conditions as they find them there. Dr. R. Van Saceghem, for example, predicts the total extinction of the elephant throughout the Congo within fifty years if the present killing goes on unrestricted. He even questions the right of the native to slaughter elephants not only for food but in the search for ivory, which now brings unprecedented gain. Agriculture and animal husbandry in the Congo, he argues, would undoubtedly be benefited if the native could be induced to divert his activity from wasteful elephant hunting to the cultivation of his own lands. There can be no doubt of the menace to the future stock of elephants through the indiscriminate massacre of old and young of both sexes in pits and traps.

The success of the experimental station at Api in the Uelle district has proved that the African elephant can be domesticated and taught to work, provided it is captured young. No fewer than forty elephants are now in training at Api, and a second station for the same work is to be established in the Eastern Province of the Belgian Congo, in the hope of relieving the natives, eventually, from most of the hardship of porterage.

With regard to the other large mammals needing protection, the Cercle Congolais calls attention to the success of the British colonies in tropical Africa in regulating hunting so as to attract sportsmen, increase the revenues of the colony, and yet keep intact the stock of wild game. Wise laws strictly and impartially enforced are the sole means to this end.

Conditions in the highlands of the border districts of the Congo are essentially similar to those in the Sudan and East African colonies. But it must be remembered that the forested lowlands of the central Congo basin offer difficulties which are perhaps more serious. Game is not found in herds, nor so plentifully that it would attract the sportsmen for the pleasure of hunting, nor is the climate suited to healthful exertion. On the other hand, the native population is relatively dense and virtually without domestic animals from which to draw a supply of meat. Severe restrictions on the possession of firearms by natives, and the prohibition of wasteful methods of destruction are the fundamental measures to be taken, but will required ceaseless vigilance.

The creation of game refuges in the less populous districts will prove of value, while careful study by trained zoologists on the spot will suggest further means of perpetuating the fauna, despite the exigencies of civilizing influences. The Cercle Zoologique Congolais is thoroughly aware of the need of further collecting of specimens for museums and zoölogical gardens of recognized scientific standing, and is pledged to favor every effort to spread knowledge of the animal life of the Congo basin. Only scientific investigation of the fauna can assure its survival.

PROTECTION OF FAUNA IN QUEENSLAND.—Following are some excerpts from an article contributed by Heber A. Longman to *Save Australia: A Plea for the Right Use of Our Flora and Fauna*, edited by Sir James Barrett, K. B. E., Melbourne, 1925:

"Owing to its immense area (670,500 square miles), and the variety of environmental zones, Queensland possesses a wealthy fauna containing many forms of special interest."

"In November, 1921, a new Act, known as 'The Animals and Birds Act of 1921,' containing important revisions and restrictions, was passed, and this valuable measure put Queensland into the front rank of civilized countries so far as legislation is concerned."

"In April, 1922, the Department of Agriculture and Stock issued large notices, in which the birds that are *not* protected, or partially protected, were listed, whilst in large type it was emphasized that all other wild animals or birds were totally protected during the whole year throughout Queensland. Special publicity was given to this notice by posting it on railway stations. . ."

"In March, 1923, Queensland had no less than 108 sanctuaries, including such large areas as Hinchinbrook Island (97,280 acres), Bellenden Ker Reserve (79,000 acres), Stradbroke Island (78,720 acres) and the Lamington National Park near the border of New South Wales (47,000 acres). . . ."

"The Government of Queensland has been most sympathetic to the requests of nature-lovers, and the Hon. W. N. Gillies, Minister for Agriculture and Stock, and his officers have done valuable work. Many large and

important reserves have been recently proclaimed, and additions are frequently being made. Among important proposals for the future is a reserve by the side of the main Southern railway, where travelers by mail trains will be able to see large kangaroos, wallabies, and emus in a state of nature. . ."

"Among the school children excellent propaganda has been done by the Gould League of Bird Lovers, now merged into the Nature Lovers' League of Queensland. . . ."

"Although this short account deals with mammals and birds only, it is of interest to note that the world-famous Ceratodus or Queensland Lung-fish, is totally protected by legislation. Special placards to this effect are posted on the banks of streams in Southeastern Queensland where this 'living fossil' is either found naturally or has been introduced."—H. C. R.

South African National Park.—A Bill for the permanent establishment of a great National Park and Sanctuary for wild animals will shortly come before the Union of South Africa. The Transvaal, in which the proposed park is located, has the credit of being the first state in Africa to realize the importance of protecting wild life. In March, 1898, two years before the Conference of African Powers called by the late Lord Salisbury led to the establishment of reserves and sanctuaries in many parts of Africa, the Transvaal Government had set apart a district on the Sabi River as a sanctuary, in which it was forbidden "to hunt, shoot, seek, or in any way to intimidate, to chase, or to drive, or in any way disturb any game or birds in the game reserve." During the South African War the regulation was not enforced but immediately afterward it was again proclaimed. In 1903 the sanctuary received important additions, and now occupies an area of approximately 200 miles by 60. A warden and rangers were appointed and an adequate native staff provided. In the succeeding quiet years the game, free from the attacks of man, steadily multiplied.

Elephants have been coming back from the Portuguese Territory, and with encouragement would establish themselves permanently. There are still a few black rhinoceroses and the possibility has been suggested of transporting to the reserve the few remaining white rhinos of South Africa. Hippopotami are stil plentiful. Giraffes, since the war, have been numerous. Buffaloes are present and only require the protection of the sanctuary. Zebras, wart hogs, and bush pigs exist in great numbers. Antelopes, eland nyala, kudu, roan, sable, blue wildebeeste, waterbuck, and many of the smaller forms are fairly numerous. There are lions, leopards, cheetahs, caracals, servals, hunting dogs, and hyænas. The bird life is extraordinarily rich.

EXTINCT ANIMALS

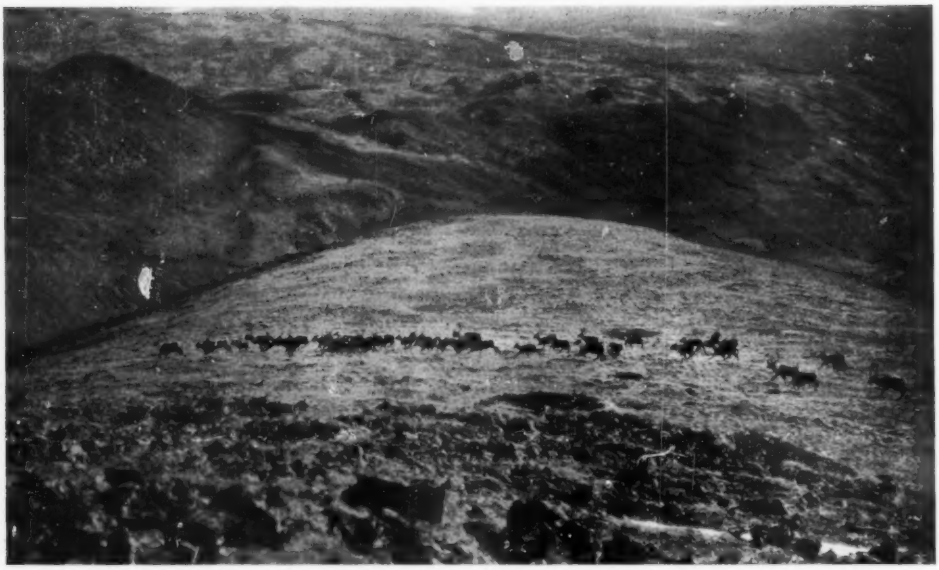
Explorations for Fossil Veretbrates.—The most important field work during the season was the Third Asiatic Expeditions' explorations in Mongolia. The results of this brilliantly successful season will be summarized by Mr. Andrews in a later number of Natural History. In addition, three expeditions were sent to the Western United States through the support of Mr. Childs Frick. The first, in the Santa Fé basin of New Mexico, was personally directed by Mr. Frick, and secured a large number of skulls, jaws, and parts of skeletons of Miocene mammals, principally deer, camels, horses, rhinoceroses, mastodons, dogs, bears, cats, and other characteristic animals of the later Tertiary period. These represent a stage in the succession of western faunas that has been imperfectly known and poorly represented in our collections.

A second expedition, in charge of Albert Thomson, continued work in the Snake Creek fossil quarries, obtaining considerable collections, although chiefly of fragmentary material, from two horizons, one older, the other later than the Santa Fé fauna just mentioned. Among the interesting finds was a skull and part of the skeleton of a rare genus of three-toed horse, *Archæohippus*. Especial search was made for additional remains of the famous *Hesperopithecus*, which was discovered in these quarries. The results of this search will be announced later after the material has been critically examined.

A third party, in charge of Doctor C. C. Mook, visited various small, scattered fossil localities in southwestern Montana and secured a number of specimens of the little-known Tertiary mammals of this region, among them skulls of squirrels, horned rodents, oreodonts, and others. An interesting fragment was an opossum jaw from the Middle Miocene, the first definite record of a marsupial from this horizon in America.

MAMMALS

Museum To Have Group of Osborn Caribou.—Mr. James L. Clark, assistant director of the American Museum of Natural



A herd of Osborn caribou (*Rangifer Osborni*) on the very top of a high mountain. The great expanse of country in the background is all caribou barrens and all well above timber line. The average herd usually contains several big bulls, which may be distinguished by their conspicuous white necks

History, in charge of preparation, has recently returned from an expedition into the Cassiar Mountains of Northern British Columbia, where he went to obtain material and studies for a habitat group of the Osborn caribou.

Since the type specimens of these fine animals were secured in 1902 by Andrew J. Stone, and described and named in honor of President Henry Fairfield Osborn, by Dr. J. A. Allen, no others have come to this Museum. This variety of caribou, which is the richest in color and largest in horn and body of all the great caribou group, is to be shown in the Hall of North American Mammals, and it is befitting that this group should be one of the finest in the whole Museum.

Facts regarding the extent of range, or even the approximate number of these caribou, are very meagre, and when in May, 1925, news was broadcast of a great gold strike in this locality, there was much concern about their welfare and that of the other game of this country.

Leaving New York August 9, Mr. Clark went from Wrangell, Alaska, up the Stikine River to Telegraph Creek, where he outfitted and proceeded by pack train to the southeast section of Dease Lake. Here he found the caribou very abundant: it was not unusual during a single day for him to observe many herds, averaging from thirty to forty animals.

Many thousands were seen in the three weeks that Mr. Clark was in their locality, and he estimates that he examined fully three hundred big bulls while engaged in selecting the largest and most typical male for the group.

He found the caribou ranging extremely high, at times on the sky-lines of the highest mountains, and always above timber line which here is about 6,000 feet), on the great rolling moss- and grass-covered plateaus of these mountains. No place seemed too high or too cold for them. They were even up on the peaks among the last year's snows, where one would expect to find only the mountain sheep. They migrate south to these undulating uplands for their summer feeding, and late in the fall return to the more open and wind-swept barrens of the North, where the snows are not so deep. It is evident, however, that a few remain throughout the winter, as some shed antlers were found.

Seven specimens in all were secured: two fine large males, two females, and two young bulls. The horns of the cows and the bull calf were still in the velvet, and this phase will be shown in the group.

PRONGHORNED ANTELOPE INCREASING.—Friends of the pronghorned antelope will be glad to learn through Dr. E. W. Nelson's report on the "Status of the Pronghorned

Antelope, 1922-1924," *U. S. Dept. of Agriculture Bull.* No. 1346, August, 1925, that the numbers of this unique American species are actually on the increase in many places. Doctor Nelson gives, in his full and comprehensive summary of conditions, many interesting facts and figures. A few passages from this authoritative paper will afford a glimpse of existing conditions:

"Where the pronghorn occurred with the buffalo, people best qualified to judge consider that it exceeded that an mal in numbers. It has been estimated that the buffalo herds at one time numbered from thirty to sixty million animals. In view of the greater territory occupied by the pronghorn and its known abundance, it may be considered a conservative estimate to place its probable original numbers at not less than thirty to forty millions, and possibly more.

"As against the many millions of pronghorns once inhabiting this continent a recent census, taken through the Biological Survey and detailed elsewhere, shows approximately 30,000 survivors.

"The hunting of antelope is now forbidden by law almost throughout its range. In the United States, of the 16 States in which these animals still occur, Wyoming is the only one in which their hunting might be legalized."

"The number of game animals of each species to be maintained in each area should be determined by a careful study of the conditions in the area by trained experts having practical knowledge of the requirements of the different species. It should be clearly understood that at the present time and for some years to come antelope need strict protection practically throughout their range, the one probable exception being in a limited area in Wyoming."

THE LION IN EUROPE.—Mr. Madison Grant presents some interesting evidence from Herodotus as to the existence, 480 B.C., of lions in Macedon, a country lying north of ancient Greece; he also cites a paragraph from Sir Harry Johnston's *The Story of My Life* as to the presence of lions in North Africa in 1880. Here is the lion statement:

"Herodotus, Book VII, verses 125, and 126, describing the march of Xeres through Macedon:

"Upon this march the camels that carried the provisions of the army were set upon by lions, which left their lairs and came down by night, but spared the men and the sumpter beasts, while they made the camels their prey. I marvel what may have been the cause that compelled the lions to leave the other animals untouched and attack the camels, when they had never seen the beast before, nor had any experience of it.

"That whole region is full of lions and wild bulls, with gigantic horns which are brought into Greece [Note by M. G: this is the urus—*Bos primigenius*]. The lions are confined within the tract lying between the river Nestus—which flows through Abderà—on the one side and the Achelous which waters Acarnania, on the other.

"No one ever sees a lion in the forepart of Europe east of the Nestus, nor through the entire continent west of the Archelous, but in the space between these bounds lions are found."

THE LION IN NORTH AFRICA.—Sir Harry Johnston in *The Story of My Life*, p. 66, says, speaking of lions in 1880:

". . . on a high and densely wooded plateau with the higher mountains of the Aurès mass rising to about seven thousand feet. It seemed a superb country, strangely little inhabited, the last refuge of the lion, which in those days was seemingly quite common—Allégro had a tame, half-grown lion cub at his house in Bône [near to Tunis-Algerian border]; one heard the lions roaring at night time not far away, and I actually saw the male and female lion already referred to. They were killed—prosaically enough—by poisoned bait. The French had accumulated a great herd of cattle . . . and their presence at the camp attracted the lions and leopards. In the course of a few more years the lion in these regions and elsewhere in North Africa became completely extinct. The leopard still lingers, here, in Western Algeria, and Morocco. Those I have seen—dead or stuffed—in Morocco-Algeria, struck me as being exceptionally large, compared to the two or three varieties seen in India, Malaysia, and tropical Africa. Their rosettes are larger, more jaguar-like, and some of the males attain the dimensions of a large jaguar."

A NEW HANDBOOK.—The department of mammals has just published, as No. 61 of the *Guide Leaflet* series, a handbook on "The Capture and Preservation of Small Mammals for Study," by H. E. Anthony. This paper has been written for those who wish to learn

how to collect and make study skins of small mammals. Frequently sportsmen have inquired how they could preserve and bring back for the Museum the many interesting small mammals they find while hunting for big game, or younger men searching for museum technique and collecting experience have asked for some handbook on the subject. "The Capture and Preservation of Small Mammals for Study" devotes about fifty pages to the more important details, and has twenty-four illustrations showing how to skin small mammals, make a collecting chest, etc. Copies of the handbook may be purchased at the sales booth, Memorial Hall, or at the library.

OTHER MUSEUMS

THE NATURAL HISTORY MUSEUMS OF LENINGRAD AND MOSCOW.—Curator Bashford Dean is returning from one of his annual tours of Europe in the interests of the Metropolitan Museum of Art and the American Museum of Natural History. From Leningrad he sends to Professor Osborn a letter, dated July 18, 1925, describing the present progress of the Russian museums of art and natural history, which contains most gratifying news to lovers of art and of nature. The following is a free transcription of his letter:

"Professor Karpinskii still presides over the Zoological Museum of Leningrad, where we enjoyed a glimpse of veritable treasures. The last boreal mammoth (*Elephas primigenius*) is mounted just as it was found hunched up in a little gully at the mouth of the Lena River. True, it is somewhat 'doctored,' for the back had been eaten off by dogs or wolves, the face badly damaged, and the trunk was missing, but the fine long 'wool' shows its ruddy color, and the stumpy tail is quite unlike that of the second fine skeleton, which suggests that the first tail was not 'right.' So fresh was the meat that the zoölogist in charge of the party ventured to cook and eat a bit of it; it nearly killed him—three weeks abed of ptomaine poisoning! The skeleton is mounted near by and is the only one absolutely complete (one foot is plaster-boned, but the real foot is close at hand in a jar of alcohol). Pity that we cannot land such a monster in the American Museum! The ice rhinoceros heads are quite as good in their way, the latest one so good that it is, alas, smelly! It is a miracle to see these beasts in the flesh.

"There is, too, a fine Steller's sea cow which lacks only its flippers. I went over the material of *Rhytina* which is in their storeroom, and there is unfortunately little to tempt one. There are about thirty skulls, quite a lot of vertebræ, a few complete ribs and parts of others, but sketchy at the best. I think of Doctor Townsend's chances to get a quantity of this material in the North Pacific in his "Albatross" days! The extinct cormorant I did not see; it has been carried off to the safe against possible troubles here.

"Paleontologists would be delighted with the Stegocephalians and Theromorphs. The Leningrad Museum has a lot of them; in a cliffside a whole cemetery has been unearthed where the whole beasts come out in consecutive lumps. That there are Permian mammals the people here doubt not at all. I saw, too, all the material of Karpinskii's queer shark teeth *Helicopriori*, which seems to straddle the balance spring of a huge watch; how the great creature would have appeared living is a problem indeed!

"We are much impressed by the interest which the present government is giving to museums. There are forty museums, open and active in Moscow, including one of the best art museums I have ever seen, and thirty-seven in Leningrad. The museum galleries are full of students of all ages, guided by instructors. I learn that everything possible is being done toward giving scientific education to the young."

BICENTENARY OF THE RUSSIAN ACADEMY OF SCIENCES.—The American Museum is one among many scientific institutions invited to attend the bicentenary of the Russian Academy of Sciences. As we were unable to send a personal representative, Professor Peter Sushkin carried for us the following letter to the President of the Academy:

"DEAR PRESIDENT KARPINSKII:

The comparatively youthful American Museum of Natural History, founded in 1869, sends its greetings to the Russian Academy of Sciences at Leningrad on the celebration of the two-hundredth anniversary of its foundation. On this auspicious occasion the members of our scientific staff desire to reaffirm our admiration for Russian achievement in every branch of Natural History and our desire to continue and to strengthen our scientific intercourse with Russia in every branch to which Russian naturalists have devoted their lives.

"In zoölogy we especially acknowledge our indebtedness to the explorations and writings of Pallas, Middendorff, Eversmann and, Przewalski. In paleontology we honor the names of Kovalevski, Amalitzski, Cherski, Borrissiak, and Pavlov. In embryology and comparative anatomy we place on our honor roll the names of Metchnikoff, Kovalevski, Zalenski, Wolff, von Baer, Severtzov; in invertebrate zoölogy, those of Korotneff Bobretski, and Nassonov. We pay tribute in geology to Inostrancev, Mushketov, Karpinski, Pavlov, Obrutcher; in ichthyology to Grimm Kessler, von Baer, Eichwald, Berg, Schmidt, Nordmann, Borodin; in the explanation and description of bird life to Severtzov, Menzbier, Zarudny, and Sushkin; in mammalogy, besides the early explorers mentioned above, to Satunin and Nassonov; in anthropology, to Anutchin and many others.

"For the past half-century the explorers of the American Museum of Natural History have been welcomed to the study and examination of the collections in Russian museums, have been conducted through the paleontologic and geologic wonders of the Russian country, and have been welcomed in their own explorations, geologic, palæontologic, and anthropologic, to the farthest zones of Russian culture and civlization. Thus in science have been maintained the
of mutual good will and interchange of
ought and interest which have also been
intained between the Russian and Ameri-
peoples at large.

"With our felicitations and best wishes for
ew century,.

HENRY FAIRFIELD OSBORN,
President."

SCIENCE OF MAN

In the hall of the Age of Man, American Museum, is a fine exhibit of the fossil remains
he most primitive known member of the
an family, the *Pithecanthropus erectus* Dubois, the ape-man of Java. This exhibit has been prepared and arranged by Prof. J. H. McGregor of the department of zoology, Columbia University. Explanatory cards and labels clearly set forth the significance of each fossil and cast, so that "he who runs may read."

APPOINTMENTS

THE UNIVERSITY OF VIENNA has called Professor Jan Versluys of Hilversum, Holland, as chief of the Morphologische Institut; he takes this position October first. Dr. Wilhelm Marinelli, who has been carrying on his researches in the American Museum during the past six months, is leaving here to take the position of assistant in the Institut. Coordinated with morphology in the University is the Physiologische Institut for the directorship of which no appointment has as yet been made. Both Doctor Versluys and Doctor Abel, of the Paleobiologische Institut of Vienna, have had intimate relations for many years with the American Museum, and in saying good-bye, Dr. Wilhelm Marinelli takes to Professor Versluys President Osborn's congratulations and the assurance that the American Museum will always be ready to coöperate, so far as is in its power, with this new branch of the great Austrian university.

NEW MEMBERS

SINCE the last issue of NATURAL HISTORY, the following persons have been elected members of the American Museum, making the total membership 8324:

Fellow: MR. FREDERICK STURGES, JR.

Life Members: MRS. PAUL MOORE, PROF. ULRIC DAHLGREN, MESSRS. WALTER H. ALDRIDGE, LEO S. BING, NICHOLAS F. BRADY, HANS V. BRIESEN, IRVING T. BUSH.

Sustaining Members: MISS CHARLOTTE R. STILLMAN, MESSRS. FREDERICK LYON, WILLIAM HALE PRICE.

Annual Members: MESDAMES META BALLY, HELEN PARRISH BROWN, HAROLD FRANK, JACQUES R. FREEDMAN, FRED. A. GEIER, EDWARD GLUCK, CECIL CAMILLE MARTIN HARRIS, ELIZABETH H. PARKS, F. I. W. ROBINSON, A. L. SHERWIN, E. H. SPOONER, MILTON S. STEINER, SAMUEL RICHARDS WEED; the MISSES FLORA M. CAMPBELL, MAUD S. CLARK, SARAH E. DOLBEY, JANE KENNEY, MABEL R. SWARR; PROF. HAROLD L. ALLING, PROF. WILLIAM PRAGER, DOCTORS FRANCIS X. DERCUM, ANTHONY H. HARRIGAN, FERDINAND G. KNEER, ROBERT L. LOUGHRAN, EDWARD H. RAYMOND JR.; MESSRS. OTTO P. AMEND, GEORGE WARRINGTON BASS, DUDLEY J. BACHRACH, HARRY R. BALTZ, JOHN BANTZ, STEPHEN BIRCH, ADOLPH BLOCH, ROBERT E. BOYD, WILLIAM B. CABOT, GEORGE EUSTIS CORCORAN, BELMONT CORN, WALTER B. ELLWOOD, FRANCIS R. HALSEY, ROYAL F. HINMAN, J. FREDERICK JONES,

FRED. R. LONG, MORTON J. NEWBURGER, THOMAS DE QUARTEL RICHARDSON, JR., ANTON R. ROSE, JOSEPH STERNFELD, ROY G. THOMAS, COLUMBIA GRAMMAR SCHOOL.

Associate Members: PROF. CARL BARUS; MESDAMES CHARLES BRADLEY, GILBERT C. CARPENTER, JOHN ARMINGTON DAY, GILMAN DRAKE, D. GHIRARDELLI, E. L. HUTCHINSON, JOSEPH E. JENCKES, CHILSON LEONARD, HENRY L. WILKINSON, EDWARD CLARK WRIGHT; the MISSES GWENDOLYN CURTIS, JANE P. HUBBELL, DOROTHY B. MOULTON, ELEANORE W. PARMELEE; DOCTORS ALEX. M. BURGESS, L. F. DE BEAUFORT, WALTER K. FISHER, GORJANOVIS-KRAMBERGER, HERLWYN R. GREEN, PHILIP A. LOOMIS, JOHN C. SPENCER, K. L. STOLL, ALANSON WEEKS, THEW WRIGHT; JUDGE JAMES WICKERSHAM; MESSRS. SPENCER BORDEN, ARTHUR D. CHAMPLIN, E. DONALDSON CLAPP, CHAS. J. DEERING, CHARLES M. DISERENS, THOMAS B. DOYLE, DAVID W. EATON, H. JOHN FALKNER, OTTO F. FELIX, B. FRANK GREAVES, LAURENCE H. HASELTON, FRANCIS WINGATE HAYES, C. F. HOLDSHIP, P. S. HOPKINS, JOHN MARTICH, L. H. MCLAUGHLIN, EDWARD H. MERRITT, FRANCIS H. MOORE, JR., GEO. L. PAYNE, GEO. WHITEFIELD PRICE, BROCKHOLST M. SMITH, F. M. SMITH, JULIAN A. STEYERMARK, LEON MAX STONE, JOS. S. THOMPSON, JAMES E. THURSTON, JOHN TEMPEST WALKER, TALBOT C. WALKER, MANFRED L. WARREN, ANDREW WELCH, GERALD WHITMAN, MOUNTFORD S. WILSON, RUSSELL C. WILSON, ROBERT S. WOODS.

PRESENT RACES OF MAN

JANUARY-FEBRUARY

The first number of **Natural History** for 1926, edited by Dr. Clark Wissler, curator-in-chief of the division of anthropology, is to be devoted to present-day man with special reference to his physical characters. In this issue Prof. Raymond Pearl of Johns Hopkins stresses the distinction between the stationary upper limit or span of life and the mean or average length of life which is now being rapidly increased. Dr. Rueben Ottenberg puts man into four classes according to the presence or absence of two substances in the red corpuscles of the blood which may by mixture cause it to coagulate.

Dr. Milo Hellman explains the relation existing between the shape of the human face and the form of the jaws and teeth. Dr. Charles B. Davenport discusses the several methods which have been employed in recording skin color and sets forth the advantages of the color-top with glass disks of various colors which are blended by spinning.

The Indians of California are classified according to bodily form by E. W. Gifford of the University of California. He finds three main types, one of which, the largest, is again divided into three subtypes.

Professor Fay Cooper Cole of the University of Chicago writes on the races of Malaysia which include a supposedly aboriginal population of pygmies and immigrants of other types, one of which has extended its range throughout the Pacific Islands. In connection with their racial characteristics he describes their customs.

Two little known tribes of Colombia, one on the mountains and one on the coast, are contrasted as to physical appearance, customs, and general bearing, by Dr. John Alden Mason, assistant curator of Mexican archæology.

Prof. Frank G. Speck of the University of Pennsylvania describes a night under the stars during midwinter in Labrador and suggests that at one time houses had only one side wall and no roof.

Dr. Gilbert L. Wilson, who in times past made many visits to North Dakota for the Museum, gives in a dialogue a view of the difficulties a man of mature years must undergo to change his ways of life.

Prof. Osborn discusses in biological terms the varieties of living men, the evolutionary results of man's past life, and suggests what might result in the future if certain occupations should be continued for many generations.